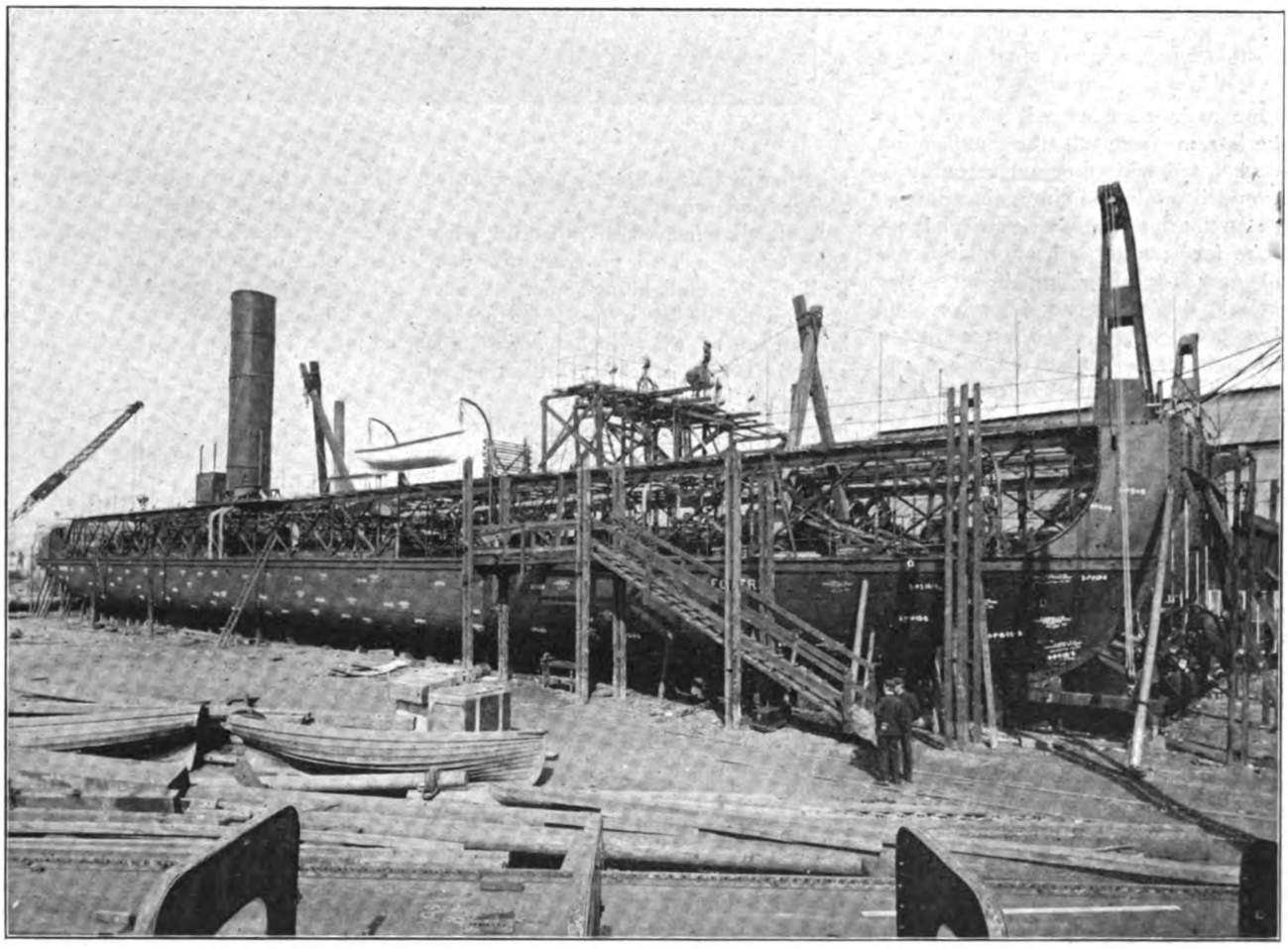
THE MARINE REVIEW

VOL. XXXIV. CLEVELAND, JULY 12, 1906. No. 2.

A NEW DREDGING VESSEL FOR INDIA.

Amongst the many notable dredging vessels constructed by Messrs. Wm. Simons & Co., Ltd., of Renfrew, one of the most noteworthy is the suction-pump canal embanking dredger Foyers now completed by them for the government of India.

The length of this vessel is 250 ft.; the breadth, 45 ft.; and the depth, 18 ft. The hull has three complete bows, and is of unique form. Designed specially for opening up new waterways and improving the depths of shallow canals or rivers, the dredger is able to cut a canal or channel about 20 ft. wide at bottom in one cut. Suction frames are led through the two open walls created at the fore part of the ship by the formation of the bows. Each suction frame has two suction orifices, and carries two patent rotary cutters arranged to work in advance of the suction nozzles for disintegrating clayey material which would otherwise be unsuitable for suction pump dredging. Each suction frame is also provided with a row of water jets for agitating compact sand which might not be resistant enough to warrant the employment of the rotary cutters. Water for the jets is supplied at high pressure from two special centrifugal pumps in series, driven by enclosed high-speed compound engine. Each pair of cutters is driven by bevel and spur gearing from an independent four-cylinder tandem-compound engine.



SUCTION DREDGER FOYERS.

The cutters, made of cast steel throughout, are of Robinson's patent type, very massive in construction and

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of special form. Each suction frame is controlled by independent hoist gear driven by two-cylinder engines. The two centrifugal and sand-suction pumps have a nominal dredging capacity of 4,000 tons of sand per hour from a depth of 20 ft. The pumps deliver the material dredged direct through a floating pipe-line 600 ft. in length and 42 in. diameter. The pipe line is raised by a terminal pontoon to a height of 20 ft. above water level, and the material is finally discharged over the canal bank to a distance of 100 ft. from the center of the terminal pontoon. The pumps are specially constructed with wide spaces to permit of the passage of large pieces of debris. All surfaces liable to the erosive action of the sand are fitted with adjustable wearing pieces. Each suction pump is driven by an independent set of vertical triple-expansion engines of 900 I. H. P.

Another feature is that the dredger is fitted with three propellers, each driven from a separate set of vertical compound surface-condensing engines of sufficient power to obtain a speed of eight knots per hour.

One main condenser is provided to take steam from all the engines on board, fitted with a complete outfit of steam-driven air and circulating pumps. The auxiliaries include a vertical long-stroke feed pump, with automatic control gear for supplying boilers, two vertical duplex general-service and bilge pumps, two feed-water filters, each arranged so that the other can be overhauled when the dredger is at work; evaporator for providing fresh water, complete electric light installation, with search lights at each end; refrigerating plant and cooling chamber for preserving stores, etc.

A tool room is provided on deck containing a forge and a number of machine tools, so that, irrespective of the location of dredging operations, repairs may be speedily effected on board without recourse to shore shops.

Steam is provided by four Babcock & Wilcox water-tube boilers constructed to Lloyds requirements for 200 lbs. working pressure. Reducing valves are fitted as required to auxiliary engines. The funnel is arranged to hinge down for passing under bridges.

The material raised by the suction pumps is discharged over the stern by a special swiveling connection, so arranged that the floating pipe line can be connected directly aft, or to a range of 90 degrees to either side of center of the dredger.

The floating discharge pipe line consists of ten circular pontoons each carrying a 42-in. diameter pipe, 60 ft. long, coupled together by a special flexible connection. At the end of the floating line of pipes a terminal pontoon of rectangular form is provided fitted with a massive crane for supporting the embanking discharge pipe, which pipe has an outreach of 100 ft. from center of pontoon at a height of 20 ft. above water level. This pontoon is fitted with two steam winches, each having three barrels arranged to work together or independently of each other as occasion requires.

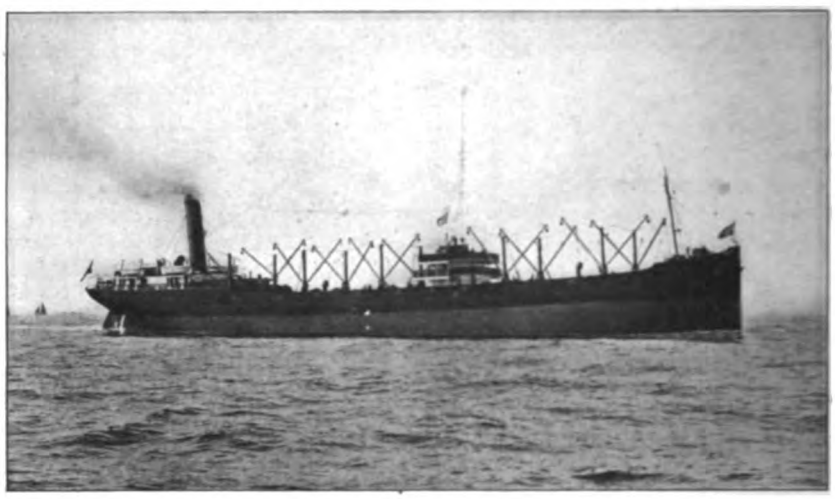
A steam winch with powerful wire-rope tackle is also provided for controlling the embanking pipe. A vertical tubular boiler is fitted for providing steam to the winches, etc. The special feature of this pontoon is an outboard balance weight carried on heavy davits from side, so arranged as to maintain the trim of the pontoon irrespective of whether the embanking pipe is full or empty. A telephone connection is installed between the terminal pontoon and dredger.

Telegraphs are fitted from an operating bridge on the dredger to all working parts, so that one man stationed on this bridge can control all operations from this position.

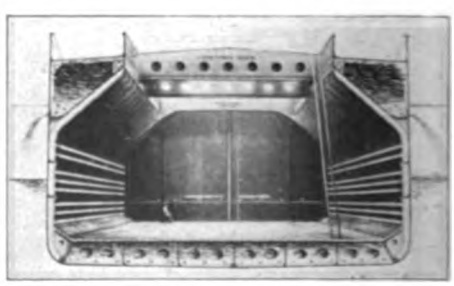
The vessel will be despatched to India, where it will be employed in dredging the shallow rivers in the Bengal Presidency. It was designed on the initiative of Mr. O. C. Lees, superintending engineer, Southwestern Circle, Bengal Public Works Department, India, after a careful and exhaustive study of existing British, American and other types of dredge plant. The Foyers has been constructed under the direction of Sir A. M. Rendel, consulting engineer for the Indian government, under the direct superintendence of Mr. Seymour B. Tritton, London, assisted by Mr. Gaze, resident inspector.—[*Engineering Times.*

NEW TYPE OF FREIGHT STEAMER.

One of the latest and most up-to-date freight steamers, especially for the trade in which she is to be employed, is the Borgestad which has just recently arrived from across the Atlantic to take up her place under charter of the Dominion Coal Co., Sydney, Nova Scotia, for their important coal trade between that port and Montreal. She has been built by Sir Raylton Dixon & Co., Ltd., of Middlesbrough, to the order of the Statsraad Gunnar Knudsen, of Porsgrund, Norway, for the Aktieselskabet, Borgestad. The leading dimensions are: 372 ft. long over all, 51 ft. beam and 29 ft. deep and she carries over 7,000 tons of coal on a draught of 23 ft. 1 in., at an average speed of over 11 knots per hour when loaded and steams over 12 knots when light. Her most remarkable feature is that she is a perfect self-trimmer, no coal trimmers being required either



FREIGHT STEAMER BORGESTAD.



VIEW SHOWING CANTILEVER SYSTEM.

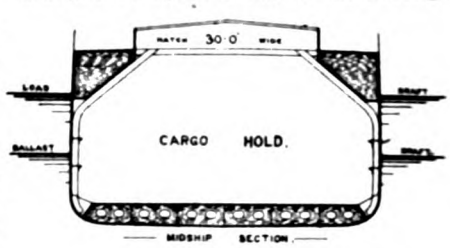


DIAGRAM OF BORGESTAD'S HOLD.

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in loading or discharging which is done at the rate of 1,000 tons per hour.

For the return voyage she is provided with 75 per cent more water ballast than usual which is carried in tanks at each side of the holds under the deck, and so incorporated with the frames as to add immensely to the longitudinal strength of the ship. In outward appearance she very much resembles the large freight steamers on the great lakes, having her engines placed right aft and very wide hatchways. The strongest type of vessel afloat on light draught renders this cantilever system an ideal one for the lakes service and her immense capacity suitable for either grain self-trimming, iron ore, timber or wood pulp, etc., etc., are further recommendations.

The rig and general appearance is extraordinary, for she has no masts, and is fitted with ten derrick posts in pairs, which although not required in the Dominion Coal Co.'s trade on the St. Lawrence will be necessary in general trades in which she will be employed during the winter.

This type is classed by all of the classification societies, Lloyds, British Corporation Veritas and Norwegian Veritas, to the rules of the last of which the Borgestad has been built, under special survey.

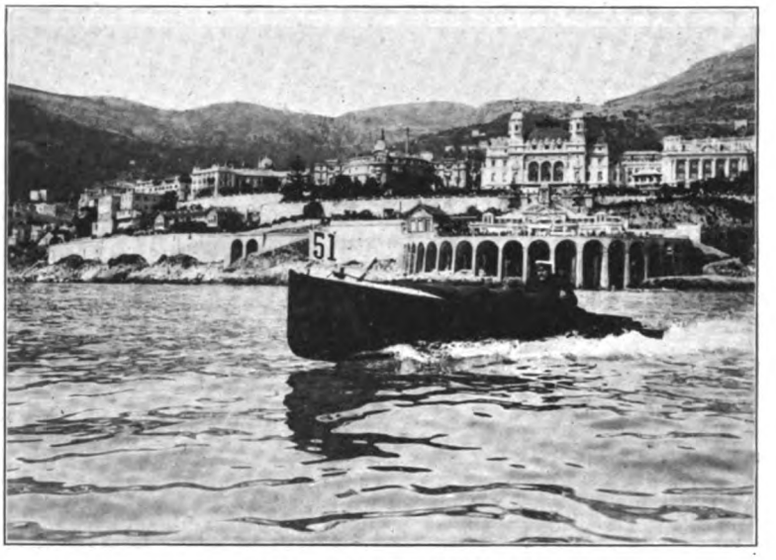
Her engines are built by the Northeastern Marine Co. at Sunderland, and have cylinders 26, 42 and 70 in. diameter by 48-in. stroke. Two boilers of 180 lbs. pressure, 15 ft. diameter by 11 ft. 6 in. long and one 11 ft. diameter by 10 ft. 6 in. long fitted with Howden's forced draft will indicate 2,200 I. H. P.

BRITISH MOTOR BOAT REGATTA.

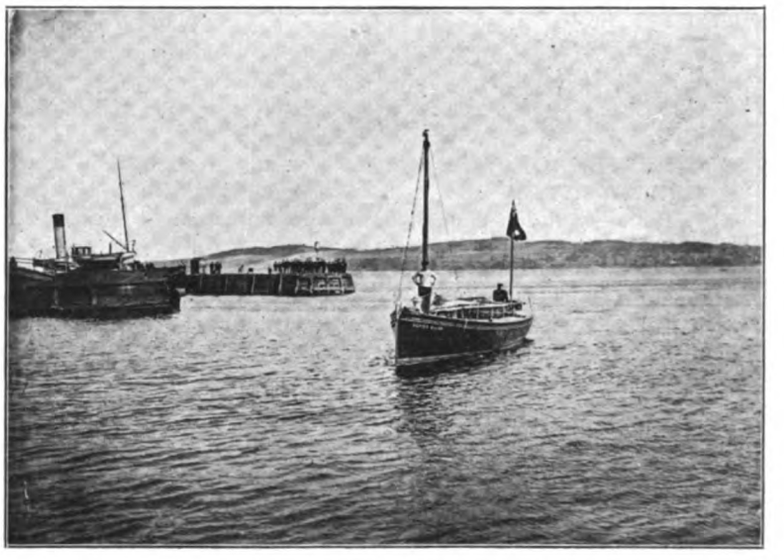
The international motor boat regatta, organized under the joint auspices of the British Motor Boat Club and the Liverpool Bay yacht club, took place on the Mersey on June 8 and 9. Some interesting events were gone through, and some of the most famous "flyers" known in the motor world competed. In the race for "40-footers," Mr. J. G. Hutton's famous Hutton II was entered, and her chief opponent in this class was the speedy steam-propelled boat Rose-en-Soliel, owned by Lord Howard de Walden. A considerable interest was taken in this latter boat, largely owing to the fact that she is propelled by a pair of steam-driven Simpson-Strickland engines, driving twin screws. Her hull lines are very easy and free, and when traveling at slow speed she presents rather a pretty and buoyant appearance on the water, although somewhat top-heavy. Her displacement is four tons, and she is little more than a racing freak, requiring about 30 gallons of water and 43 gallons of fuel per hour, thus narrowing down her field of operations to very little over one hour's running. In the race the Rose-en-Soliel completed the first round of the course in a smother of spray about a quarter of a mile ahead of Hutton II, both boats traveling very fast. Unfortunately, due to some misunderstanding, Rose-en-Soliel did not accurately follow the course marked out, and although she completed the course and finished nearly a mile ahead, she was disqualified in consequence of this breach of the course regulations. On the second day's racing, Rose-en-Soliel secured a handsome win over Defender I (second), Javelin (third) and Hutton II, her time showing that she went over the 20-mile course at the rate of 25.4 miles per hour. She completed the course in the splendid time of 47 min. 31 sec., the Defender I, finishing second, occupying 1 hr. 39 min. 21 sec. and Javelin (third), 1 hr. 48 min. and 9 sec. Hutton II broke down and did not complete the course.

The next race of importance was a handicap for motor boats not exceeding 30 ft. over all, but only the Takumono and the Javelin turned up out of the four entered. The Takumono is a lighter craft than her competitor, and has a much faster running engine, making perhaps 1,200 revolutions to the Javelin's 800. The course was 16 knots, and Takumono was an easy winner, her time being 1 hr. 15 min. 7 sec. She is owned by Mr. Miall Green, rear commodore of the British Motor Boat Club. The Javelin finished three minutes later.

In the cruisers' race for boats over 25 ft., only Napier Major and Defender I competed. Defender I led



MOTOR LAUNCH TAKUMONA.



NAPIER MAJOR.

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throughout, but the prize was awarded to Napier Major on a time allowance of 42 min. 42 sec. The time occupied in running the 16 knots' course was 1 hr. 58 min. by the winner, and 1 hr. 18 min. 39 sec. by Defender I.

The race for motor boats not exceeding 18 ft. over a course of 8 knots was won by Mr. W. H. Wiswall's Iris, which won the recent race from New Rochelle to Block island, up to such magnificent craft as Lysistrata, Margarita, Lorena, Niagara and the other great steam yachts.

The arrangement of the page has been greatly improved, a smaller but very distinct type giving space for much additional information, in particular, by means

MOTOR BOAT IRIS.

and another race for motor boats and dinghies not exceeding 16 ft. was won by Mr. W. Scott-Hayward's Pop.

In the race for the British motor boat flying mile cup, Hutton II, having broken down, the steamboat Rosen-en-Soliel was the only competitor. The course was over the official admiralty measured mile, and this she covered in the remarkably quick time of 2 min. 12 sec., her speed thus working out at 27.3 knots.

LLOYDS REGISTER OF AMERICAN YACHTS.

The activity and prosperity of the present yachting season is mirrored in the annual edition of Lloyds Register of American Yachts, which has just been launched in new and improved shape. When first published four years ago, the American register was modeled largely after its English namesake, but the changing conditions of yachting have shown the necessity for a complete rearrangement and revision.

The new volume is deeper than the old (7¼ by 9¼ in.), with a proportionate decrease of thickness, thus making a more shapely volume and one more easily handled, while the number of entries has been increased from ten to fifteen to the page. The old arrangement of two separate lists of power and sailing yachts has been abandoned, and there is now a single list of yachts in alphabetical order. This list includes 3,399 yachts of all types and sizes, from the little 18-ft. sloop Okee, of special abbreviations, the type of cabin, such as trunk cabin, hunting cabin, etc., is indicated. The particulars of the various types of gas engines now so generally used in yachts are very fully given, a new feature being the special type of engine, four-stroke or two-stroke.

One of the most interesting features of the book, as indicating the recent growth of yachting in America, is the club list covering 34 pages and containing the full particulars of 302 yacht clubs. This list includes the Royal Bermuda Yacht club and the Hawaii Yacht club, each conspicuous just now in connection with ocean racing, the Royal Vancouver Yacht club and its neighbor the Seattle Yacht club (also the new Seattle Power Boat club), the South Coast Yacht club, of Lower California, the Royal Halifax Yacht Squadron of Nova Scotia, the Halifax River Yacht club and a dozen other clubs of the Florida peninsula and the Gulf coast and, in addition to the well-known clubs of the coast and the great lakes, newer and smaller clubs in every section of the country. The burgees of these clubs will fill nine large color plates in addition to 25 plates with 1,576 private signals of individual yachtsmen throughout the United States, the Dominion of Canada and the West Indies.

For the first time the various yachting associations of the country are included; with the rest, the American Power Boat association.

A specially interesting feature of the club list is the number of new clubs devoted to power boats, many of these with fine club houses and large lists of members being established on the inland rivers where sailing is impossible.

New and very complete lists are given of American designers, yacht builders, engine builders and sailmakers, making a full directory of this side of the sport.

The list of yacht owners includes some 3,300 names, the address of each owner being given with the clubs to which he belongs and the yachts owned by him; a special key number refers to the cut of his private signal in the color plates.

The book is very handsomely made, bound in blue cloth, with all gilt edges and with the old seal of Lloyds Register of Shipping in gold on the cover. It is published by Lloyds Register of Shipping, 15 Whitehall street, New York.

THE FUTURE OF THE TURBINE.

Mr. Charles E. Allan, director of Messrs. Workman, Clark & Co., Ltd., of Belfast, who built the Allan line turbine steamer Victorian, has just stated to a press representative that he regarded the Victorian's performance of her last trip as an important vindication of the principle of the turbine engine no less than as a satisfactory result of the experiments made by the firm with new propellers. During the recent overhaul necessitated by the vessel having gone ashore last winter, improvements were introduced into the turbines, and three-blade propellers substituted for the original four-blade ones. A distinct improvement in speed was shown in the trial trip after the alterations which had now culminated in the vessel beating by 2½ hours the record set up by her sister ship, the Virginian, built on the Clyde, and engined by Parsons. The performance is enhanced owing to the ship having to go considerably to the southward on her voyage to avoid ice. "I always had confidence in the Victorian and in turbines," said Mr. Allan, although the ship was under a cloud at the commencement, and her comparative failure in speed was made the basis of apprehensions as to the reliability of this type of engine, so much so that there were indications of a desire to return to reciprocating engines for high-speed ocean steamers. The Victorian has not only rehabilitated herself, but has removed any doubts as to the future of the turbine. He looked confidently for even better results from both turbine vessels in the future.

President Roosevelt has signed the Lake Erie & Ohio River ship canal bill, thus giving a charter to the corporation for the construction of the canal from Pittsburg to Lake Erie ports. It is estimated that this canal will cost $46,000,000.

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THE NEW CUNARDERS.

BY SIR WILLIAM H. WHITE, K. C. B., IN THE LONDON TIMES.

The launch of the Lusitania at Clydebank recalls attention to the characteristic features of the two great Cunard steamships which are being built under special agreement with the British government. The fundamental condition of that agreement is that these vessels shall be "capable of maintaining a minimum average ocean speed of from 24 to 25 knots in moderate weather." The fulfilment of this condition will restore to the British flag the supremacy in speed on the trans-Atlantic service which was long maintained, but which passed to the German flag nine years ago. The Campania and Lucania (built in 1892-93) still remain the fastest British steamships; they are 620 ft. in length over breadth, 7½ ft.; depth, 52½ ft.; gross tonnage, 13,000 tons; displacement (at draught of 28 ft.), 20,000 tons; they are propelled by twin-screw engines of 30,000 H. P., and have attained 22 knots. The North-German Lloyd steamship Kaiser Wilhelm II began her service in 1903 and has the following characteristics: 706 ft. length over all; breadth, 72¼ ft.; depth, 52½ ft.; gross tonnage, 19,360 tons; displacement (at 29 ft. draught), 26,000 tons; speed, 23½ knots; H. P., 40,000. Increase in speed from 22 to 23½ knots consequently involved about 30 per cent increase in displacement and horsepower; the water-line length was increased by 86 ft., and the cost by 50 per cent.

To endow the new Cunarders with as great a superiority in speed over the German steamship as she possessed over the Lucania was a formidable undertaking. The laws of steamship propulsion are well understood, and to increase speed across the Atlantic from 23½ to 25 knots involved much greater proportionate increase in engine-power, coal consumption, and dimensions than that involved in passing from 22 to 23½ knots. Precedents had to be surpassed and many difficult problems solved. To this solution the officials of the Cunard company and several of the leading firms of British ship builders devoted assiduous attention for a long time before the designs of ship and machinery were completed. The agreement between the government and the Cunard company embodied the payment of a considerable annual subsidy, and important financial arrangements in regard to capital expenditure, and the admiralty, who were closely concerned with the leading features of the design, rendered valuable assistance, including experiments with models in their tanks at Haslar. As consulting naval architect to one of the firms finally entrusted with the design and construction of these two vessels, the writer is personally acquainted with all of the details of procedure. In his experience there has been no design for which the investigations that were made before dimensions and structural arrangements were finally settled have been more thorough and extensive. Experimental inquiries were combined with scientific calculation; every precaution was taken to obtain the best results as regards form, dimensions, economical propulsion, strength, stability, good behavior, passenger accommodation, and efficient working of the propelling apparatus. It soon became obvious that the engine power required must be from 60 to 70 per cent greater than that of the Kaiser Wilhelm II, and the coal consumption proportionately increased. The installation of this immense power and of the corresponding coal supply was no easy matter. In round figures 1,000 tons of coal will have to be put into the furnaces in every 24 hours during the trans-Atlantic passage. The most careful consideration was given to the arrangements of boilers and coal-bunkers, in order to attain maximum efficiency and economy of labor. Had it been possible to secure adequate supplies of oil-fuel at reasonable rates the advantages would have been enormous; the economy in weight of fuel would have been very great, the labor of transporting the fuel from the bunkers to the furnaces would have been minimized, and the operations of replenishing the bunkers would have been facilitated and simplified. It was, however, decided that the design must provide for the use of coal; if the supply of oil-fuel could be insured later on, there would be no difficulty in making the necessary modifications.

The choice of the most suitable propelling apparatus also involved considerations of alternative types of machinery. If reciprocating engines had been adopted, triple-screws and three sets of machinery would have been necessary. Each set of engines would have been of greater power than a set of engines in the Kaiser Wilhelm II. It would have been necessary to place one set abaft the other two; consequently engines of enormous power and with great weights in the moving parts would have been installed far aft, and there would have been risks of objectionable vibration, even when all possible precautions had been taken to balance moving parts of the engines. Furthermore, the manufacture of the screw-shafting, and particularly that of the crank-shafts, would have involved great difficulties, as the sizes required would have been far beyond precedent. The directors of the Cunard company, therefore, appointed a special committee for the purpose of considering and reporting on the possible adoption of turbine machinery. That committee included representatives of the Cunard company, the admiralty, Lloyds register of shipping and the firms to whom it was proposed to entrust the construction of the ships and their machinery. Mr. Brock (of Messrs. Denny's firm, whose experience in the construction of turbine steamships for the mercantile marine was exceptionally great), also served on the committee, which consisted, with one exception, of marine engineers, the writer being the only naval architect. Mr. Parsons, to whose genius the introduction and development of the marine steam turbine is due, prepared the designs of the machinery submitted to the committee; and the services rendered by him and by his staff in the course of the inquiry were of immense value.

Certain advantages attaching to the use of turbines had been demonstrated before the work of the committee began, chiefly by experience with installations on land, but partly with turbines fitted in cross-channel steamers and torpedo craft. Freedom from vibration, reduced cost of maintenance and working expenses, greater economy in the use of steam at or near maximum power, capacity to run continuously for long periods without sensible deterioration in condition, and power to take considerable overloads without injury were amongst the proved qualities of turbines; evidence was available also to show that turbines increased their economy with increase in size and power. All these features were substantiated by the committee by independent investigation. By the courtesy of the Brighton Railway Co. and of Messrs. Denny, trials were made of sister ships, one fitted with turbines and the other with reciprocating engines, and the results were favorable to the turbines, confirming the conclusions previously reached from the working of other channel steamers. At that time the cruiser Amethyst had not completed her trials, but she represented the greatest horsepower applied to marine turbines—her three turbines being estimated to develop from 12,000 to 14,000 horsepower. The Allan line had decided to use turbines in two new trans-Atlantic steamers of large size, but the power was not greater than that of the Amethyst, and the work of construction was in an early stage. An enormous advance, therefore, had to be made if turbines of nearly five times the power were to be installed

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in the new ships. Indeed, the step forward in power was practically as great as the total advance made gradually with reciprocating engines in from 40 to 50 years. The committee fully appreciated the magnitude of the new departure and the necessity for careful attention to details of design and manufacture; but after careful review of all the circumstances they recommended the directors of the Cunard company to approve the use of turbines as the best possible solution of the problem. This recommendation was confirmed by the directors; the sanction of the admiralty to this change in propelling apparatus has since been emphasized by the adoption of turbine machinery in all vessels recently ordered for the royal navy, from the great battleship Dreadnought down to the "coastal destroyers." The Cunard company decided also to fit turbines to the Carmania, and so to gain at an early date their own experience of the system as applied to large steamships by comparing her performances with those of the sister-ship Caronia, which is fitted with reciprocating engines. Instead of the triple-shaft arrangement of turbine machinery which had been adopted in most steamers, the Lusitania and Mauritania, on the recommendation of the committee, will have four propelling turbines, each working a separate shaft and propeller, and two reversing turbines will be fitted on the shafts nearest to the middle line of the vessels. In this manner the sizes of the turbines will be kept down and the total power will be distributed; but even under these conditions the moderate rate of revolution adopted results in very large dimensions of the turbines and their castings. Many problems arose in connection with the quadruple screws, their positions and dimensions. They have been experimentally investigated in order to discover the arrangements most favorable to economical propulsion. In actual service perfect organization of the engine room and stokehold staffs will be necessary, of course, to secure continuous development of power, and economy of coal consumption. The past history of the Cunard company makes it certain that this will be secured; but the chief engineer of one of these ships will have an unprecedented responsibility to bear, and upon the capacity of himself and his assistants much must depend. The "human element" is still of very great importance to efficient steamship performance.

The boilers are of the ordinary cylindrical ("Scotch") type, 25 in number, all but two of them being double-ended. There will be four funnels. The steam pressure is about 200 lbs. per square inch. Howden's system of forced draft will be fitted, and the air-supply fans are to be driven by electric motors. Electricity will be largely used for lighting, ventilation, working of lifts, and other auxiliary purposes. Current will be generated by steam turbines instead of the reciprocating engines usually employed; noise and risk of vibration will thus be minimized.

Before the dimensions and forms of the vessels were definitely determined extensive experiments were made with models tested in the admiralty tank at Haslar, and great advantage resulted from this investigation. The dimensions finally adopted are as follows: Length over all, 790 ft.; length at water-line, 760 ft.; breadth, extreme, 88 ft.; depth, 60½ ft.; at 33½ ft. draught of water the displacement will approach 40,000 tons; the weight of the materials in each of the ships and her machinery, will be about 30,000 tons. The proportion of length to breadth is not so great as in preceding trans-Atlantic steamers of recent date. The water-line length in the Lucania is 9.2 times the beam; in the White Star Oceanic, 10; in the Kaiser Wilhelm II, 9.5, and in the new vessels 8.6 times the beam. This change in proportion secures the association of extremely fine ends with greater proportionate beam, and favors economical propulsion at maximum speed. A notable increase in proportionate depth has also been made; the length at water-line in the Lucania and Oceanic is about 14 times the depth; in the Kaiser Wilhelm II it is 13 times, and in the new vessels about 12.6 times the depth. This increase in relative depth greatly favors the provision of longitudinal strength, and the greater length of the new ships will tend to diminish the longitudinal bending moments impressed on the structures when exposed to the action of Atlantic storm waves. High tension steel has been used extensively in the hulls for the purpose of associating more fully strength with lightness. The vessels are to be classed at Lloyds. Their water-tight subdivision is very thorough and is much improved by the introduction of the four turbines which are placed in three separate engine rooms. All provisions for safety at sea have been most carefully considered in the design. There are six complete decks, including promenade and boat decks. The passenger accommodation will be on the most elaborate and generous scale, and provision will be made for carrying about 550 first-class, 500 second-class, and 1,300 third-class passengers. The complement of officers and men will be about 800, so that when each ship is full about 3,200 persons will be embarked, and will be insured excellent accommodation.

In consequence of the large dimensions of the Lusitania, her weight at launching will be exceptionally great—over 16,000 tons—but its distribution will be favored by her enormous length. Her experienced builders will be sure to take every precaution to insure safe launching, and all interested in the future of our mercantile marine will wish them and the Cunard company success, not only in that operation, but in the completion and trials of the great ship.

SUBMARINE SOUND SIGNALING.

BY FERDINAND HEFELE, NAVIGATING OFFICER, HAMBURG-AMERICAN EXPRESS STEAMSHIP DEUTSCHLAND.

The submarine signaling apparatus has been often spoken of in different daily papers and technical magazines, and some practical tests which have been made with it on the steamer Deutschland, of the Hamburg-American line, may be of particular interest now. In order to attain the greatest possible safety in navigation, it has always been sought to extend the usefulness of the present fog signals. Very recently the attempts of Leithauser aimed to increase the value and usefulness of fog signals by means of more varied applications suited to special conditions; but unfortunately all these experiments were valueless because of the uncertainty in ascertaining the direction of the sound since the results were often exactly opposite one another.

It having been ascertained that the sound under water, unlike sound in the air, is independent of the direction and strength of the wind and, further, that it has a velocity of about 1,400 meters per second under water as compared with only 330 meters in the air the thought occurred to an American to use the water instead of the air for the propagation of sounds to be used as fog signals.

This invention consists of a so-called receiver apparatus and the sending apparatus. The sound producer is a bell placed on a lightship, or a buoy, and is sounded either automatically or by electricity or compressed air. The bell has generally a weight of 150 lbs. and hangs, for example, on the Weser lightship, at a depth of about 22 ft. under water. The receiver is placed on each side of the bow of a ship and entirely within the ship, and has the form of a cylinder. It is approximately three meters from the bow and is

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placed between the water line and the keel. It is made of iron and has a diameter of 16 in. and a height of one and a half feet. One end of this cylinder is closed by a convex side, while the end on skin of the ship is open, that is, the end of the receiving case lies directly against the ship's skin and is made water-tight by means of a rubber gasket. This receiving tank is filled with water, and carries a small microphone shaped like a pocket-watch, which is connected by telephone conductors with the officers' bridge. The telephone upon the bridge is now connected with the receivers on each side of the ship; and since the navigating officer can shut out, at will, one side or the other, it is easy to determine from which side, starboard or port, the sound comes.

The experiments upon the Deutschland, as well as upon the North German Lloyd ships, have given very satisfactory results. On the American coast, for example, the Nantucket lightship, in a heavy sea, has been heard at a distance from four to five miles quite distinctly. At first the strokes of the bell were heard in both receivers, proving that the lightship must have been ahead. After a change in the course, the tones on the starboard side were the clearer; and they disappeared on the port side. Very seldom indeed is it possible to determine with such accuracy the sound direction by means of fog horns. At the time of passing the Weser lightship, the sea was quiet and the signal in consequence was heard up to six miles.

When the Deutschland lay at Dover we heard quite distinctly the hammering and riveting of the workmen who were constructing a pier under water; while nothing whatever could be heard out of the water. In Plymouth, we distinguished the noise of the machinery of a submarine boat, which was passing quite near the Deutschland. No deception was possible; the boat was first heard through the submarine telephone, before it showed itself above the surface of the water.

It is not difficult to make even a wider application of the apparatus for the war marine. Of what importance would it be, for example, if one could determine in fog or in darkness the approach to the channel buoys of the enemy? The new discovery promises both an apparent guarantee for the avoidance of stranding and collisions. It is a pleasure to know that the Hamburg-American line in their ships of the future, will make use of the invention.—German *Nautical Magazine.*

COMMERCE OF LAKE SUPERIOR

The commerce of Lake Superior as measured by the statistics kept by the superintendent of the canal at Sault Ste. Marie was during June the heaviest ever known. The freight moved through the canals aggregated 7,025,235 tons, exceeding by nearly 1,000,000 tons the record breaking month of last year. The total commerce to July 1 of the present year was 14,877,780 tons as against a movement of 13,133,444 tons to July 1, 1905. Following is the summary:

MOVEMENT OF PRINCIPAL ITEMS OF FREIGHT TO AND FROM LAKE SUPERIOR.

Items	To July 1, 1906.	To July 1, 1905.	To July 1, 1904.
Coal, anthracite, net tons	192,083	294,337	219,941
Coal, bituminous, net tons	2,111,114	1,572,717	947,946
Iron ore, net tons	10,366,948	9,812,041	1,385,054
Wheat, bushels	21,354,474	10,906,000	11,389,673
Flour, barrels	1,578,148	1,199,014	559,545

REPORT OF FREIGHT AND PASSENGER TRAFFIC TO AND FROM LAKE SUPERIOR, FROM OPENING OF NAVIGATION TO JULY 1 OF EACH YEAR FOR THREE YEARS PAST.

EAST BOUND.

Items	To July 1, 1906.	To July 1, 1905.	To July 1 1904.
Copper, net tons	34,301	35,679	12,081
Grain, other than wheat, bushels	18,052,685	9,160,115	6,093,306
Building stone, net tons	.....	4,638	2,850
Flour, barrels	1,577,963	1,198,839	559,545
Iron ore, net tons	10,366,948	9,812,041	1,385,054
Iron, pig, net tons	8,517	20,657	4,380
Lumber, M. ft. B. M.	277,093	279,492	198,567
Wheat, bushels	21,354,474	10,906,000	11,389,673
Silver ore, net tons	.....	.....	407
Unclassified freight, net tons	58,433	25,865	13,111
Passengers, number	5,085	4,871	2,905

WEST BOUND.

Items	To July 1, 1906.	To July 1, 1905.	To July 1, 1904.
Coal, anthracite, net tons	192,083	294,337	219,941
Coal, bituminous, net tons	2,111,114	1,572,717	947,946
Flour, barrels	180	175	.....
Grain, bushels	6,749	63	625
Manufactured iron, net tons	121,241	38,598	26,382
Salt, barrels	151,183	169,729	84,931
Unclassified freight, net tons	316,707	207,385	112,378
Passengers, number	6,170	5,257	2,701

SUMMARY OF TOTAL FREIGHT MOVEMENT IN TONS.

	To July 1, 1906.	To July 1, 1905.	To July 1, 1904.
East bound freight of all kinds, net tons	12,112,667	10,995,233	2,269,847
West bound freight of all kinds, net tons	2,765,113	2,138,211	1,319,277
Total freight, net tons	14,877,780	13,133,444	3,589,124

Total number of passages to July 1, 1906, was 7,086, and the registered tonnage, 12,324,736.

SHIP BUILDING IN THE UNITED STATES.

During the fiscal year ended June 30, 1906, 1,463 merchant vessels were built and officially numbered by the Bureau of Navigation, measuring 421,744 gross register tons, compared with 1,301 of 326,213 gross tons for the fiscal year 1905. Of the new tonnage 384 vessels of 73,399 gross tons were unrigged barges and canal boats. The year's increase has been entirely in steel steamers on the great lakes numbering 52 of 237,724 gross tons, compared with 29 of 102,497 gross tons for 1905. The former year of greatest lake construction was 1901 when 175 vessels of all types of 169,085 gross tons were built. Three steamers over 7,000 gross tons were added this year to the lake fleet, the J. Pierpont Morgan, 7,161 gross tons, being the largest.

On the seaboard only two steamers for foreign trade have been built, Mexico and Merida, 6,207 gross tons each, under mail contract to Cuba and Mexico and built to replace two steamers sold to the government's line to the Isthmus of Panama. Only one other ocean steamer over 1,000 tons was built. Remaining large steamers are for ferry, river or bay service including four for New York's city-owned ferry system.

Only five schooners over 1,000 tons were built, compared with 14 in the fiscal year 1905.

In compliance with a provision of the current naval appropriation bill, the secretary of the navy has sent a circular to all private constructors asking them to submit preliminary plans for the battleship of 20,000 tons displacement recently authorized by congress. Compensation will be given to such constructors as compete whether their plans are accepted or not.

The bureau of construction and repair will shortly begin plans for the construction of two torpedo boat destroyers which were provided for in the last naval appropriation act.

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THE MARINE REVIEW

DEVOTED TO EVERYTHING AND EVERY INTEREST CONNECTED OR ASSOCIATED WITH MARINE MATTERS ON THE FACE OF THE EARTH.

Published every Thursday by

The Penton Publishing Co.

CLEVELAND.

BOSTON NEW YORK
DULUTH PHILADELPHIA
CHICAGO PITTSBURG
CINCINNATI

Correspondence on Marine Engineering, Ship Building and Shipping Subjects Solicited.

Subscription, $3.00 per annum. To Foreign Countries, $4.50.
Subscribers can have addresses changed at will.

Change of advertising copy must reach this office on Thursday preceding date of publication.

The Cleveland News Co. will supply the trade with the MARINE REVIEW through the regular channels of the American News Co.

European Agents, The International News Company, Breams Building, Chancery Lane, London, E. C. England.

Entered at the Post Office at Cleveland, Ohio, as Second Class Matter.

JULY 12, 1906.

GOVERNMENT ARMOR PLATE.

The house of representatives recently passed an act requesting the secretary of the navy to appoint a special committee to investigate the desirability of establishing a government armor plate mill. This is the revival of an agitation which was in full flower about four years ago, but was supposedly at that time crushed forever. A government armor plate mill is inconceivable nonsense. The original agitation had as its incentive the supposedly high price of armor plate. Probably it was high (it is somewhat lower now), but the cost per ton was by no means as high as it would be under government manufacture. There are only three companies that undertake to manufacture armor plate in this country, the Carnegie, the Bethlehem and the Midvale Steel companies. The obstacles to profitable manufacture lie in the initial cost of the plant and the limited demand for the output. If the government were to establish a plant it could not manufacture armor plate as cheaply as the private companies, to whom the product is but a department of its ordinary steel-making business. The special commission which investigates the subject thoroughly will find that the government had better let the armor plate making business alone.

FOR MEN ABOARD SHIP.

On page 21 of its present issue, the MARINE REVIEW opens a competitive course in self instruction for wheelsmen and watchmen. Every wheelsman and watchman is therefore advised to read the particulars of the competition in this issue. This course is under direct charge of a competent lake navigator and is entirely aside from the course of lessons now running in the REVIEW by Mr. Clarence E. Long. The MARINE REVIEW begs to announce, however, that beginning next week a similar competitive course for masters and mates will be conducted by Mr. Long personally in these columns. Every master and mate is therefore advised to obtain next week's copy of the REVIEW for the first list of questions. Adequate prizes will be given to the contestants to stimulate a friendly interest in the competition. Masters and mates may derive general information concerning the conditions of the course by reading the announcement in this issue to wheelsmen and watchmen. It is hoped that the liveliest possible interest be taken in the course.

SHANGHAIING PREVENTED.

Congress has justly and sensibly come to the rescue of Jack in the passage of an act to prohibit shanghaiing in the United States. This cruel practice has been in vogue for many years in the United States in making up crews for departing vessels. The cheap boarding houses along the water front were searched for seamen who, upon being found, were either drugged or made drunk and while in that condition carried aboard to revive only after the vessel was far away at sea. To be drunk while ashore is a common failing among seamen. It is natural that it should be so. Debarred by their calling from the ordinary ties of society, the saloon is practically the only place where social intercourse is open to them. Congress, therefore, has justly made shanghaiing a penitentiary offense. The act is as follows:

That whoever, with intent that any person shall perform service or labor of any kind on board of any vessel of any kind engaged in trade and commerce among the several states or with foreign nations, shall—

First. Procure or induce or attempt to procure or induce another by force, threats, or representations which the person making them knows or believes to be untrue, or while the person so induced or procured is intoxicated or under the influence of any drug, to go on board of any such vessel.

Second. Induce or procure or attempt to induce or procure another by force or threats, or by representations known or believed by the person making them to be untrue, or while the person so induced or procured is intoxicated or under the influence of any drug, to sign or in any wise enter into any agreement to go on board any such vessel to perform service or labor thereon, shall be fined not less than one thousand dollars or imprisonment for one year, or both.

SEC. 2. That whoever shall knowingly detain on board any such vessel any person induced to go on board thereof or to enter into an agreement to go on board thereof by any of the means defined in section one hereof shall be punished as provided in section one.

SEC. 3. That whoever shall knowingly aid or abet in the doing of any of the things declared unlawful by sections one and two of this Act shall be deemed a principal and punished accordingly.

SEC. 4. That sections four, six, and twenty-four of chapter twenty-eight of the Acts of Congress, approved December twenty-first, eighteen hundred and ninety-eight, shall apply to all vessels engaged in the taking of oysters, anything in section twenty-six of said last-mentioned Act to the contrary notwithstanding.

Approved, June 28, 1906.

RECKLESS NAVIGATION.

So numerous have been the accidents owing to thick weather during the present spring and summer that it is pertinent to inquire whether vessel masters are conforming to the rules regarding navigation in fog. Information has reached a few of the leading owners of notable instances of reckless navigation during foggy weather and the matter has been presented to the supervising inspector of the steamboat inspection service for attention. The law requiring three blasts of the whistle to be sounded every minute when navigating during a fog, is not being complied with. Passing signals are also generally ignored and there is also disposition on the part of some masters to go too fast in a fog. Vessel owners are desirous of having it borne home to their captains that they are under great responsibility for the safe navigation of the ship during foggy weather, and that every regulation making for the safety of the vessels should be observed. They want the master to be sure of his position and not take any chances. If held up by a fog the question of schedule need not

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bother him at all. It is better to stop a boat in deep water than to run on the rocks. There have been recently instances of collisions, narrowly averted, owing to failure to observe the ordinary rules of navigation that some of the vessel owners are going to trouble and expense to definitely locate these reckless navigators. As soon as proof can be established against them their licenses will be revoked. The situation is particularly aggravating to the line managers who, of course, carry passengers and are charged with the safeguarding of life. Recently on Lake Michigan a steamer, apparently loaded with iron ore, crossed the bow of a package freighter within 200 ft., disappearing in the mist, the rush of water from her bow being the sole indication of her presence and the evidence of her unwarranted speed. If the identity of this boat could have been discovered powerful interests would have endeavored to prevent the master from ever sailing again. Lake navigation has grown into a mighty important trade. The personal investment in the single ship afloat is frequently as high as three-quarters of a million dollars. It is altogether too precious an asset to be recklessly handled.

THIRD LOCK AT SAULT.

As a result of the recent inquiry by the Lake Carriers' Association at Washington, definite provision will be included in the next river and harbor bill for a third lock at Sault Ste. Marie to be located north of the Poe lock. The appropriation for the lock is the largest single lake item in the bill. The lock will be built to accommodate a draught of 25 ft. and is estimated, roughly, to cost $10,000,000. Altogether the bill will carry about $15,000,000 appropriations, two-thirds of it authorizations and one-third money immediately available. About $2,000,000 is appropriated for the Cleveland harbor and $2,000,000 for the improvement of the lower Detroit river. It is understood, also, that the bill will contain an authorization for the deepening of the connecting waterways to either a 22-ft. or a 25-ft. stage. A report as to the cost of this improvement has been submitted to the war department, but the cost of the 25-ft. waterway is so greatly in excess of a 22-ft. channel that it is not likely to be considered.

QUESTIONS FOR WHEELSMEN AND WATCHMEN.

The MARINE REVIEW opens this week a course of self instruction for wheelsmen and watchmen by the question method. The first list of questions is appended herewith. The REVIEW has made arrangements with a competent lake navigator to conduct the course and the questions asked will be of practical value to all wheelsmen and watchmen. The chief merit of this course will be that those who follow it will be educating themselves as practical navigators. It is the desire that wheelsmen and watchmen answer these questions personally and mail their answers to this office, being careful to sign their names and addresses legibly. The instructor will examine each letter and mark upon it the percentage of correct answers and at the end of the season the contestants holding the four highest percentages will each be presented with a prize. These prizes will be of such a character as to stimulate active competition. The holder of the highest grade will receive a gold watch valued at $50; the second highest a pair of marine glasses valued at $25; the third highest a gold ring or scarf pin valued at $15; and the fourth highest a complete set of lake charts and two years' subscription to the MARINE REVIEW; or if the winners elect, they may receive their prizes in gold as follows: $50, $25, $15 and $10. The winners will be subjected to a personal examination by our instructor at some appointed place, in order to give everyone assurance that the contest has been won upon actual merit. The correct answers for each week will be published at the end of the month and at the close of the competition all competitors' names and averages will be announced in the MARINE REVIEW. This course is absolutely guaranteed to prepare wheelsmen and watchmen for advancement as well as any nautical school possibly can, and at far less cost—merely six cents a week.

Mr. Clarence E. Long, whose lessons on scientific navigation are now running in the MARINE REVIEW will explain variation and deviation and the working of charts in his lessons in the near future. The 1905 charts will be accepted as correct as to variation and distances. It is understood that this contest is entirely apart from the course of lessons now being conducted by Mr. Long. The MARINE REVIEW has again and again been assured by vessel owners that there is a growing demand for competent young men aboard their ships. Vacancies are constantly occurring in mates and masters' berths and owners are naturally desirous of filling these places with the most resourceful men. The knowledge that the wheelsmen and watchmen will obtain in following this course will be of great assistance to them in securing desirable berths. Following is the first list of questions:

1. How many points in the compass?
2. How many degrees in a circle?
3. How many degrees in a point?
4. How many cardinal points in the compass?
5. How many inter-cardinal points in the compass?
6. How many quadrants in the compass?
7. Name them.
8. What quadrants do you add westerly variation?
9. What quadrants do you subtract easterly variation?
10. What quadrants do you subtract westerly variation?
11. What quadrants do you add easterly variation?
12. What is the opposite course to N E ½ N?
13. What is the opposite course to SE ½ E?
14. What is the reverse course of N E?
15. What is the reverse course of E?

CAPT. ALEX. J. McKAY.

Capt. Alex. J. McKay, who has just been appointed grand treasurer of the Ship Masters' Association, has practically sailed all his life, having been in the employ of the Detroit & Cleveland Navigation Co., since 1876. He began as watchman and passed rapidly through the grades of wheelsman, second mate, first mate, assuming command of the City of Mackinac, now the State of New York, in 1883. He later commanded the State of Ohio and took the present steamer, the City of Detroit, in 1890. He is the senior captain in the service of the Detroit & Cleveland Co. Capt. McKay has gone through all the offices in the Ship Masters' lodge. He served six years as president of Detroit lodge No. 7 and a year as treasurer. He is now serving his seventh year as president of the Detroit lodge. He has represented his lodge at the annual meetings of the grand lodge on five occasions and for one year served as grand president of the association. Capt. McKay is one of the most popular masters on the lakes.

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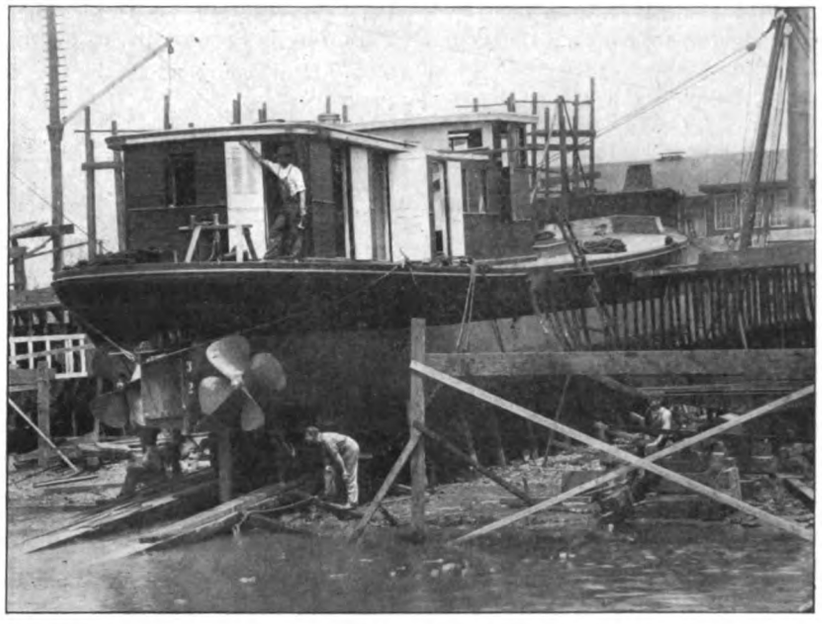
LIGHT DRAUGHT STEAMER FOR NICARAGUA.

John H. Dialogue & Son, Camden, N. J., have built a twin-screw, light draught steamer for the Ferrocarrill Nacional de Nicaragua through Messrs. Pim, Forwood & Kellock, of New York, for service at San Juan del Norte, commonly known as Greytown, Nicaragua. Her principal dimensions are: Length over all, 75 ft.; beam, 18 ft.; depth of hold, 6 ft. 6 in. She has a small deck house aft, with accommodations for crew, and half-raised pilot house. She has a large hatch forward for holding pieces of heavy machinery, with derrick and hoisting engine for handling heavy parts; also a capstan for warping the ship against heavy currents or in close places. Her engines are vertical, inverted, direct-acting, twin-screw, compound, surface-condensing, having cylinders 8 and 16 in. diameters by 12 in. stroke. The boiler is of the two-furnace, cylindrical type, 8 ft. diameter and 9 ft. long, fitted with Adamson furnaces and allowed 180 lbs. pressure. The steamer is named Blanca in honor of the wife of Gen. Zelaya, president of the republic of Nicaragua. After the arrival of the Blanca at San Juan del Norte the Hamburg-American line will resume its regular service to that port through the Atlas line steamers. This service has been suspended for some time owing to the loss of the former vessel Roseta, which the Blanca is intended to replace. The Roseta was also built by John H. Dialogue & Son. The new vessel will prove a great benefit to the merchants doing business with Nicaragua, as the Greytown route is much quicker and more convenient both for freight and passenger traffic between the United States and the republic of Nicaragua. The Blanca will leave for her destination in a few days, undertaking a very long trip for such a light draught vessel. The conditions of the contract require that she must carry at least 50 tons besides her own motive power on 4½ ft. draught, the depth of water over the bar at Greytown being extremely limited. Owing to the difficulty at docking the vessel, the bottom plates were made of iron, so as to obviate the necessity of putting her on the ways frequently.



LIGHT-DRAUGHT STEAMER FOR NICARAGUA.

The armored cruiser Tennessee, built by Cramps, was turned over to the government on July 9.

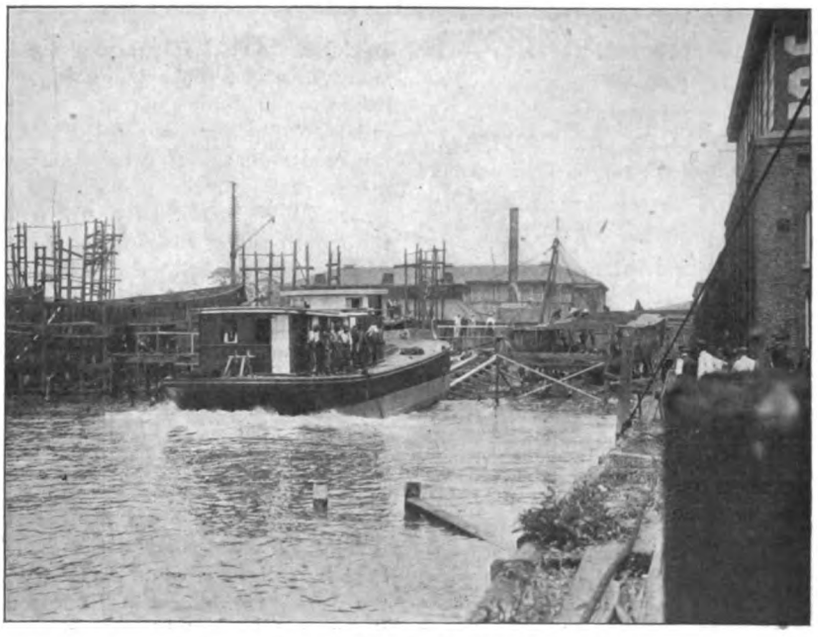
STEAM SCHOONER DELHI.

The steam schooner Delhi, built by Hall Bros. Marine Railway & Ship Building Co., Winslow, Wash., for the Pacific Coast Steamship Co., was launched June 26. The Delhi is 237 ft. 6 in. long, 39 ft. 6 in. beam and 17 ft. 2 in. deep. She will have a carrying capacity of 1,400,000 ft. of lumber. Describing her, the *Railway and Marine News* of Seattle says:

Steel straps were placed diagonally over the frames before the planking was put on. The garboards are 8 in., the bottom planking 4½ in. and the wales 7 in. The decking is 4 x 4. The stem, stern and rudder post is made of iron bark, and the balance of the timber in the hull construction is Puget Sound fir. The booms are extra heavy, and there are two masts which will handle 14 tons each. The goosenecks on the booms are 4½ in. in diameter.

The engine for this ship is a vertical three-cylinder, triple-expansion, designed to develop 800 I. H. P. at 120 revolutions per minute with a working pressure of 180 lbs. per sq. in. The diameters of the cylinders are 17 in., 27 in. and 44 in. Stroke 30 in.

The high and intermediate pressure cylinders have single ported piston valves; the low pressure cylinder has a double ported balanced slide valve. The valves are operated by the Stevenson link motion with steam starting and reversing gear.



LAUNCHING OF THE BLANCA.

The air pump is worked by a beam connected to the I. P. crosshead. The surface condenser has 1,400 sq. ft. of cooling surface. The main feed and bilge pumps are connected to the air pump crosshead; there are two of each. The steel crank shaft is 8¾ in. diameter, solid forged, and is in three interchangeable sections. The

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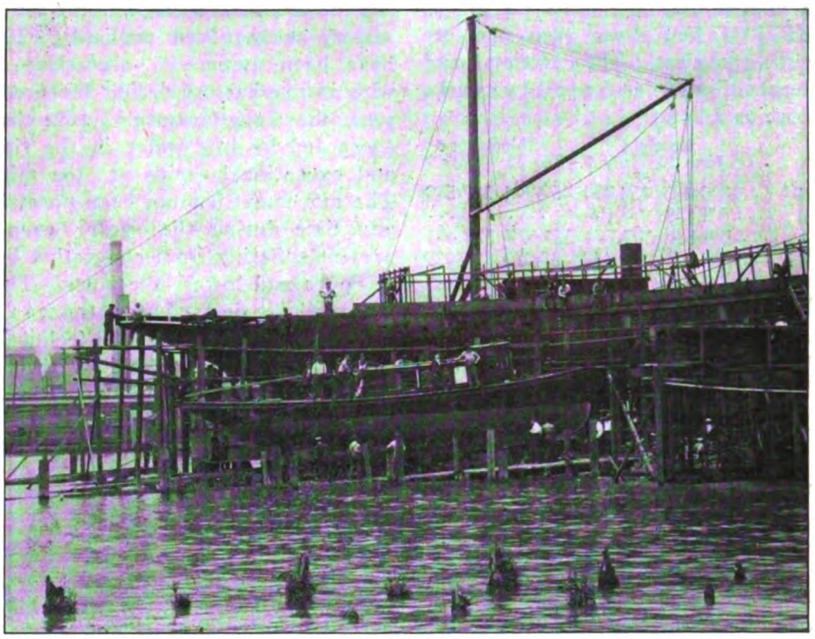
thrust bearing is of the horse shoe type and has water circulation through each shoe. The propeller is 11 ft. in diameter and 11 ft. pitch with cast iron hub and bronze blades. The electric lighting is furnished by a De Laval steam turbine and A-10 K. W. generator. The search light is a 20 amperes Carlisle & Finch. The main boilers are two, 12 ft. diameter by 10 ft. 7 in. long with three 38-in. corrugated furnaces in each boiler. Total heating surface 2,820 sq. ft. The donkey boiler is vertical 7 ft. diameter by 9 ft. 10½ in. high, with a working pressure of 100 lbs. per inch. The ship has a steam windlass on forecastle deck and steam capstan aft. There is a double set of freight winches at each hatch.

Among those who witnessed the launching were J. C. Ford, vice president and general manager of the Pacific Coast Co.; D. McKenzie, general agent Pacific Coast Co.; James Anderson, chief engineer Pacific Coast Co.; J. W. Smith, auditor Pacific Coast Co; G. W. Mertens, superintendent C. & P. S. railway; Capt. J. B. Paterson, port captain Pacific Coast Steamship Co.; Chief Allison, consulting engineer Pacific Coast Steamship Co.; C. E. Houston, coal agent Pacific Coast Steamship Co.; Dan O'Leary, master mechanic Pacific Coast Co.; Tim O'Brien, roundhouse foreman; W. W. Rafeno, port steward; C. C. Lacey, marine superintendent of the Great Northern Steamship Co.; F. W. Hibbs, of the Moran Co.; J. V. Patterson, vice president and general manager the Moran Co.; and R. J. Reekie, of the Seattle Transfer Co.

NOVEL DREDGE TENDER.

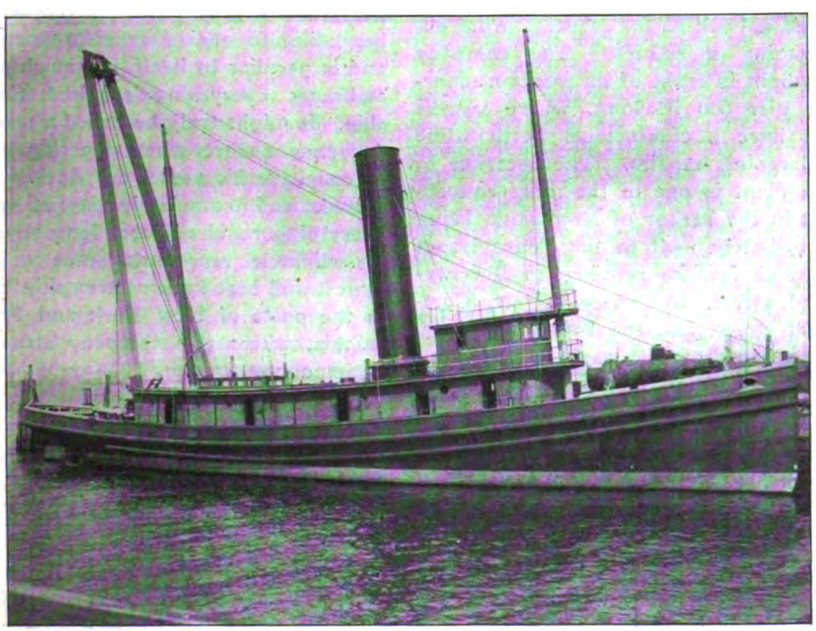
John H. Dialogue & Son, Camden, N. J., have recently constructed for the Atlantic, Gulf & Pacific Co. a small passenger boat for service with their dredges now employed in deepening the harbor at Cape May, N. J. This boat is of steel construction, 50 ft. long, 12 ft. beam and 7 ft. deep, and is intended not only to carry the crews to and from the several dredges, but is also fitted for carrying repair parts of machinery. The boat, which has been christened Florence, is fitted with a 75 H. P. Wolverine motor instead of the usual type of steam engine and boiler, thus giving added room to the crew's quarters.



DREDGE TENDER FOR ATLANTIC, GULF & PACIFIC CO.

TUG FOR LONG ISLAND SOUND.

John H. Dialogue & Son, Camden, N. J., have just completed the steel tug M. E. Scully for the Scully Towing & Transportation line of New York. This tug is of an especial type, being adapted for light draught service and having sufficient power for transporting the heaviest tows on Long Island sound. She is fitted, however, for ocean service whenever required. This tug is 140 ft. over all, 25 ft. beam and 13 ft. deep, and is fitted with steel deck house, steam capstan, steam steering gear, direct electric light plant, searchlight, as well as spars, sails and rigging. Her engines are triple-expansion, with cylinders 15, 24 and 40 in. diameters by 30 in. stroke. The boiler is unusually large, being of the four furnace Scotch type, allowed 190 lbs. pressure. Her air and feed pumps are attached to the main engine. A vertical tubular donkey boiler has also been installed, as well as a steam ash hoist.



STEEL TUG M. E. SCULLY.

W. A. Boole & Son, the Oakland, Cal., ship builders, have commenced the construction of a large steam schooner for the Sibil-Manston Steamship Co. The new craft will be christened the Sibil Manston, and will be one of the largest of the steam schooner class on the Pacific coast, having a total length of 215 ft., beam 42 ft., depth 16½ ft., and carrying capacity for considerably more than 1,000,000 ft. of lumber. Some of the frames for the new vessel were in place at the time of the earthquake, but were badly shattered, and the work has all been commenced anew.

The Racine Boat Manufacturing Co., Muskegon, Mich., are equipping their steel plant at Muskegon for handling vessels up to 200 ft. in length, putting in larger ways, a small marine railway and a complete outfit of tools.

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AT THE HEAD OF THE LAKES.

Duluth, July 9, 1906.—Grain shipments at this port have been rather light this week for there has been a plentitude of ore cargoes at 75 cents and shippers have been offered only 1¾ cents on grains, which is ¼ cent lower than the ore freight equivalent. The receipts and shipments of grain for the past two weeks compare as follows:

	Receipts		Shipments	
	June 30	July 7	June 30	July 7
Wheat	299,483	254,004	250,684	327,510
Corn	5,133	8,410	....	....
Oats	340,338	367,724	550,577	377,461
Barley	81,458	92,442	32,076	30,039
Rye	1,319	884	....	....
Flaxseed	205,549	313,810	376,192	141,492

Nearly all of the ore in the wrecked Mataafa has been lightered, some 1,500 tons remaining. The ore is being taken out with a clamshell and loaded into the Twin Sisters and the W. K. Moore and is being taken to Detroit. The ore has become very tightly packed in the hold due to the water and long standing and much of it has to be loosened with picks. The work on the Lafayette will require about six weeks more of work it is expected.

Major Charles L. Potter, who has done a great deal for the harbor at Duluth in the time he has been located here as United States engineer in charge of river and harbor work on Lake Superior, is to be transferred to Tompkinsville, Staten Island. Major Potter has been in Duluth for three years and not the least valuable of his services has been the issuance of an annual report on the commerce of Lake Superior. The third lighthouse district, which is one of the largest in the country and extends from Cape Cod to Cape May and the Delaware river, is the new station to which Major Potter is to be transferred, and he will be succeeded here by Major Graham D. Fitch, now in charge of the United States engineering office at Little Rock, Ark.

The Superior Ship Building Co. is pushing the work on the 602 foot boat for the Cambria Steel Co. and she will be launched the first week in August. Most of her plates aft are in place and the steel work on the deck house is nearly finished. Forward the work is not quite so advanced. It is stated authoritatively that upon the completion of this steamer, work will be commenced at once on a 9,000-ton freighter to be 525 ft. long.

HEAVY ORE MOVEMENT.

The ore movement to July 1 of the present year aggregates 11,241,596 gross tons, an increase of 427,542 gross tons over the corresponding movement up to July 1, 1905, when 10,814,054 gross tons were moved. The ore movement during July of the present year was 5,489,256 tons as against a movement of 4,999,450 tons for the corresponding month last year. This is an increase in the monthly movement of 489,806 tons. Creditable as this movement is, it will have to improve if shipments are to reach 38,000,000 tons for the full season, as has been predicted. There have been numerous obstacles met with in moving ore during the present year, the Longshoremen's strike being succeeded by low water in the rivers and exceptional rains at the mines. The movement has not been normal at any time during the year, even at present suffering from congestion both at upper and lower lake ports. There is excellent demand for tonnage in all trades, however, and the feeling has never been better. Provided there is not a decided slump in the early fall months, the wild rate on both ore and coal is likely to advance. Following is the ore movement by ports to date:

Port and dock	June, 1905.	June, 1906.	To July 1, 1905.	To July 1, 1906.
Escanaba	781,280	814,664	1,737,372	1,738,408
Marquette	419,955	398,490	1,017,933	802,987
Ashland	549,498	556,701	1,122,251	1,188,763
Superior	730,435	885,588	1,634,403	1,763,775
Duluth	1,379,491	1,656,831	2,747,018	3,181,235
Two Harbors	1,138,796	1,176,982	2,555,077	2,576,528
Total	4,999,450	5,489,256	10,814,054	11,241,596
1906 Increase		489,806		427,542

JAMES REILLY REPAIR & SUPPLY CO.

The James Reilly Repair & Supply Co. has recently been making some extensive improvements, both at its manufacturing and repair plant in Jersey City, and in its supply department at 229-230 West street, New York. The Jersey City plant has been entirely rebuilt and equipped with all modern tools and appliances for marine work, as well as for manufacturing engineering specialties. The company has built in front of its works a mooring pier 600 ft. long, where vessels can have a comfortable berth while undergoing repairs. The location of this plant is one of the most convenient in the harbor of New York, being immediately next to the Pennsylvania railroad ferries, running to Twenty-third street, Desbrosses street, Cortlandt street, and the Brooklyn annex. There are two Pennsylvania railroad switches in the place, one at Grand street, and one at Sussex street, making it convenient to load and unload machinery and supplies. A small industrial track runs all around the building to facilitate the handling of heavy material. Duplicate air compressors are installed and air and water pipes conducted down to the end of the mooring pier. Since the remodeling of this plant the shops have been very busy.

The new supply building on West street is one of the most modern structures of the kind in the city of New York. It has been especially built and equipped for the purpose of conducting a ship chandlery, hardware, and contractors' supply business The building is six story, 50 x 110 ft. inside, has two electric elevators, and contains besides the supply department, the general offices of the company. The business was founded in 1867 by Bartholomew Donegan and James Reilly, and was conducted by these two gentlemen until 1867 when Mr. Donegan retired. The business was then carried on by Mr. James Reilly and Mr. M. K. Bowman, who has been connected with the business since 1871. In 1892 the company was incorporated and took over the operation of the repair shops formerly conducted by the International Navigation Co. (American and Red Star lines) at Jersey City.

Mr. Reilly's prominence and well known character induced the adoption of the present title of the company. Mr. Reilly retired from business in 1896, since which time Mr. M. K. Bowman has been treasurer and general manager. Mr. C. A. Griscom Jr. has been the president of the company since its organization. The business has steadily grown from a very small beginning to one of great proportions and is peculiar in itself, inasmuch as it embraces everything required for a ship. It might truly be called a marine department store, where the ship owner can have his vessel dry docked, repaired, and completely stored with everything required for a long voyage. Its clientele represents some of the largest and best known steamship lines in the ports of New York and Philadelphia, where this company also has an important branch.

R. T. Green & Son, Chelsea, Mass., have received contract to build ten large covered barges for the Lehigh Valley Railroad Co. for service in New York harbor.

The Stanley Electric Mfg. Co., Pittsfield, Mass., has just issued a little catalog descriptive of the G. I. flush push bottom switch.

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AROUND THE GREAT LAKES

Capt. Charles E. Gary has qualified as master of the steamer Robert Holland.

The tug Alfred W., which struck a rock near Pie Island, Lake Superior, last week, will probably be a total loss.

Capt. John Mitchell sailed for Liverpool last week with his wife and family. He will be gone two or three months.

A revised chart in colors of Huron Bay and Huron Islands, Lake Superior, has just been issued by the United States lake survey and is for sale by the MARINE REVIEW.

Work was begun last week at Montreal on the new freight shed for the New England Navigation Co., which is being formed to operate a freight and passenger service between Montreal and Hamilton.

Construction of the new light house upon the north harbor pier at Milwaukee will be begun immediately. Major W. B. Judson says the building will be ready for occupancy in about five or six weeks.

Superintendent A. A. Schantz, of the Detroit & Cleveland line and the Detroit & Buffalo line, announces that it has been decided to fit all of the boats of the two fleets with wireless telegraphy. He has found it to be a great convenience.

Mrs. C. W. Elphicke, wife of the well-known Chicago vessel owner was killed last week in the wreck of the American line express train which runs between Southampton and London, the train leaving the track at Salisbury station. Vessel owners in general have telegraphed their condolences to Capt. Elphicke.

The Detroit Ship Building Co., has acquired a parcel of land 164 ft. on Atwater street, running back about 450 ft. to the river. This makes the company's river frontage aggregate about 800 ft. No program has been announced for the development of this new property.

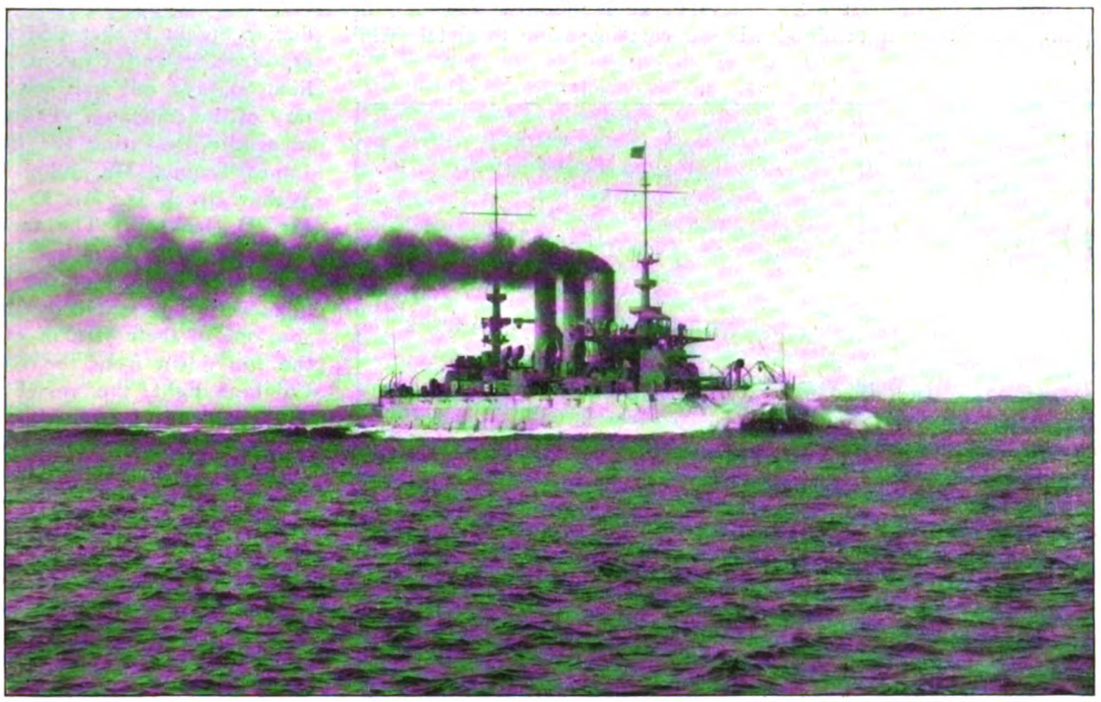
Mr. W. I. Babcock, of New York, is to make the drawings of the new wrecking tug which the American Ship Building Co. is to build for the Great Lakes Towing Co. of Cleveland. This wrecker will be much more powerful than any other wrecker on the lakes and will be designed along unusual lines.

Capt. Geo. Tebo, of Chicago, has purchased the package freight steamer John R. Sterling from the Great Lakes Engineering Works, of Detroit. The Sterling was formerly the Vanderbilt of the Weston Transit line and was taken over by the Great Lakes Engineering Works when they built the package freighter Superior.

The steamer Wm. R. Linn which was injured in collision with the steamer New Orleans is at the yard of the Great Lakes Engineering Works at Ecorse undergoing repairs. Her bow will have to be straightened and a number of new plates put on, but as her injuries are above the water line, it will not be necessary to dock her.

The old package freighter John C. Gault has been converted into a lumber and grain carrier at the Kenyon yard, Marine City. The vessel has been rebuilt from the walestreak up. Included in her equipment is an electric light plant, installed by the Great Lakes Engineering Works, and a Dake steam steerer. Alterations on the package freighter Russell Sage are now under way at the Kenyon yard. Both steamers were purchased from the Lake Erie Transportation Co. by Mr. Frank S. Upson, of Charlotte, N. Y.

The following changes of personnel in the fleet of the Pittsburg Steamship Co. have been announced: Capt. George W. Ames, promoted from first mate of steamer Bunsen to command of the steamer Cambria, vice Thomas W. Gould, resigned; Capt. S. E. Meeker promoted from first mate of the steamer Rensselaer to command of the steamer Wawatam; Capt. James Leisk takes out the new steamer Henry H. Rogers; Capt. Frank Rice transferred from the steamer Rockefeller to command of the steamer Crescent City; Capt. A. G. McLeod promoted from steamer Colgate to command of steamer Rockefeller; Capt. John McGarry promoted from first mate of steamer Bessemer to command of steamer Colgate; Mr. J. W. McEachren, chief engineer, transferred from steamer Houghton to steamer Henry H. Rogers; Mr. George Lynn, chief engineer, transferred from steamer Shaw to steamer Houghton; Mr. E. J. Rae, chief engineer, transferred from steamer Matoa to steamer Shaw; second engineer A. D. Birdsall, of steamer Coralia, promoted to chief engineer of steamer Matoa; second engineer H. P. Roberts, of steamer Bunsen, promoted to chief engineer of steamer Joliet, vice D. Milloy, resigned; chief engineer A. E. Budemeyer, of steamer Malietoa, transferred to steamer Crescent City; A. J. Armson, formerly chief engineer of steamer Grecian, appointed chief engineer of steamer Malietoa.



Built by Bath Iron Works, Bath, Me. *Copyrighted, 1906, by N. L. Stebbins.*

BATTLESHIP GEORGIA ON HER TRIAL.

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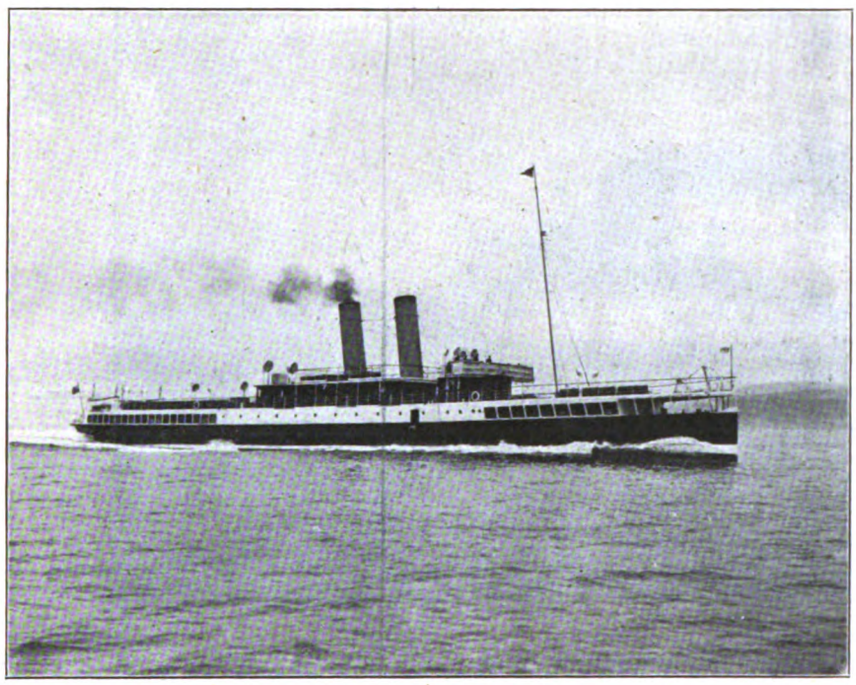
TURBINE STEAMER DUCHESS OF ARGYLL.

The turbine steamer Duchess of Argyll, built for the Caledonian Steam Packet Co., at the Leven ship yard of Denny & Bros., Dumbarton, underwent her trial trip recently, exceeding all that was expected of her.

The Duchess of Argyll embodies a considerable number of improvements due to the experience of the last five years, she being the sixteenth turbine vessel to be launched from the Leven ship yard, and in addition to this, she has had the benefit of Capt. James Williamson's great knowledge and experience of Clyde steamers. The principal dimensions are: Length, 250 ft.; breadth (molded), 30 ft.; depth (molded), 10 ft. 6 in. She is built of mild steel in accordance with board of trade requirements. The promenade deck extends from the stem to near the stern and is the full width of the vessel, above which there is a shade deck in way of funnels forming convenient landing place at low tide, special consideration having been given for landing and embarking passengers so as to avoid excessive slope of gangways. The main deck extends the whole length of the vessel, a short portion at the fore end being open above the bulwarks to facilitate the handling of ropes and moorings. Abaft the open space is the second-class saloon, which together with the alleyways at the sides of the boiler and turbine spaces form a shelter in wet weather. At the aft end is the first-class saloon, framed in padouk, a Burmese timber of very rich color. The windows are very large so as to give a clear outlook. The end bulkheads are paneled in padouk and fitted with mirrors having carved spandrels. The dining saloon on the lower deck is framed in pine finished in enamel color, the panels being of woven cane treated decoratively. In both saloons the upholstery is of uncut moquette in gold and green shades, the window curtains being to match, while a touch of warmth is added to the decorative design by Brussels carpet of rich crimson color. For convenience in handling the vessel she is fitted with a windlass and capstan forward and a steam capstan aft by Messrs. Napier, of Glasgow. Steam steering gear is provided for working the after rudder, which is of the builder's usual balanced design. A bow rudder is fitted forward to enable the vessel to be accurately steered when backing out of harbor. The vessel is fitted throughout with electric light, including masthead and sidelights. An interesting feature of the vessel is the arrangement for storing life belts, about 2,000 of which will be carried, most of them being stowed on the under side of the promenade deck in hinged racks so arranged that in a few seconds they can be made available in the event of emergency. The propelling machinery, together with the boilers, have been constructed by Messrs. Denny & Co., of Dumbarton, the turbines being of the Parsons type.



TURBINE STEAMER DUCHESS OF ARGYLL

The Duchess of Argyll, completed successfully her trial performances. On her builder's progressive trial the day was most unfavorable, there being a twenty-five mile beam wind and correspondingly rough sea. Despite this, however, she attained a mean of 20.9 knots, which under the conditions was highly satisfactory. She then proceeded to fulfil her official guarantee trials, when the owners were represented by Mr. David Todd, chairman of the Caledonian Steam Packet Co., Mr. Younger, director, and Captain James Williamson, general manager and secretary of the company. There were also present representing the builders Mr. James Denny, Mr. John Ward, Mr. Walter Brock Jr., Mr. E. Griffith, and Mr. D. Jackson. The turbines were made by the builders but Messrs. Parsons, the patentees of the marine turbine, were represented by Mr. Williamson, one of their staff of experts. On the run down from the Cloch to the Cumbrae light, the vessel attained a speed of 21.65 knots, while the mean of the two runs, up and down, was 21.11 knots, the up run being against a strong tide. The freedom from vibration and easy steaming of the vessel were matters for great satisfaction to all concerned, and on the completion of the day's running the Duchess of Argyll was taken over by her owners.

HEAVY ORE SHIPMENTS.

Duluth, July 9.—The ore sent down the lakes this week just past was a gratifying shipment though the boats were handicaped both by Fourth of July idleness and lowness of the water at the crossing. The Missabe docks are credited with a remarkable twenty-four hours' record for a period ending at 10 a. m., Sunday. A total of 117,000 gross tons was shipped, but this mark was probably obtained by taking a period which saw a bunch of boats get away and does not represent an average for that time though it is remarkable nevertheless. The shipment of ore to date is as follows; figures being bill of lading weights:

For the week, ending July 7, 1906, Two Harbors, 248,008; Duluth, 357,557; Superior, 202,282 tons, making a total for seven days of 807,847 tons. For the first week of July last year the shipments were Two Harbors, 203,043; Duluth, 261,400; Superior, 204,363 an increase on each of the docks save the Allouez and a total increase of 139,041 tons. The total shipment this year up to July 8, from the north shore is 8,390,607, bill of lading weight, which is a deduction of one per cent from the railroad weight. This is an increase over last year of 726,136 tons.

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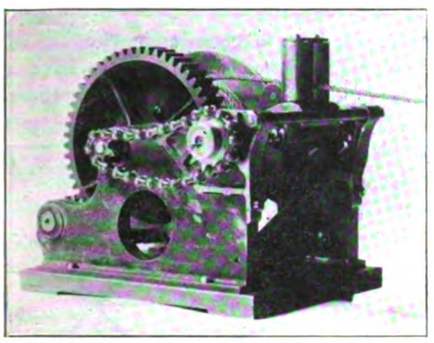
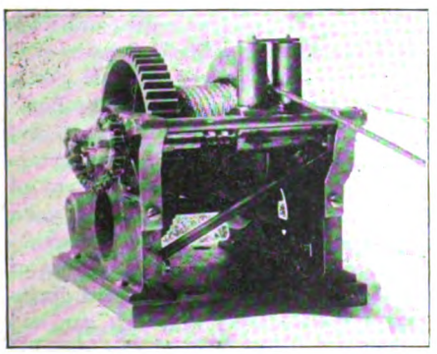
IMPROVEMENT IN TOWING MACHINE.

The American Ship Windlass Co., Providence, R. I., is just now bringing out a new feature in connection with



their automatic towing machines. This feature consists of a device for automatically winding the hawser on and off the drum of the towing machine. The idea of the invention is to wind and unwind, automatically, the hawser in even layers on the drum. The device consists of a carriage carrying two vertical rolls and a sheave on which the hawser rests, this carriage being carried on two guide rods and operated by what is known as a diamond screw, with right and left threads cut upon this same screw. This screw is driven by means of a silent chain from the drum shaft. The carriage is made in halves and bolted together and has a swivel nut in the center, as shown in the drawing. In operating, when this nut reaches either end of the thread of the screw, it travels through a groove so arranged that it is turned into the reverse thread without changing the direction of rotation of the screw.

The device is mounted upon two frames, which are so made that they can be attached to the bits or housings of the towing machines. There is also a tie or chafing rod upon which is mounted a roller, which prevents the hawser from chafing the carriage when it is being hauled in slack, and the hawser never



touches this roller when it is taut. Some of the advantages to be derived from the use of this device are: First, the rope or hawser will always be wound on the drum in even layers. Second, this will be done automatically instead of being done manually as at the present time. Third, this device does away with the clumsy wooden towing bitts and chafing rolls which have heretofore been necessary, thereby saving the deck space. Fourth, the device enables the company to supply a machine which is entirely self-contained, no bitts or other extra material being necessary, thus making the Shaw & Spiegle automatic towing machine absolutely perfect in operation. The drawing shows the device as applied to a model of a towing machine test at the works of the company. It worked beautifully. The device can be attached to any hoisting engine or other rope winding machine and will be found very valuable in connection with the same. Another feature of the towing machine is the automatic device for controlling the strain upon the hawser. This automatic device is absolutely positive in its action and is of strong construction and design.

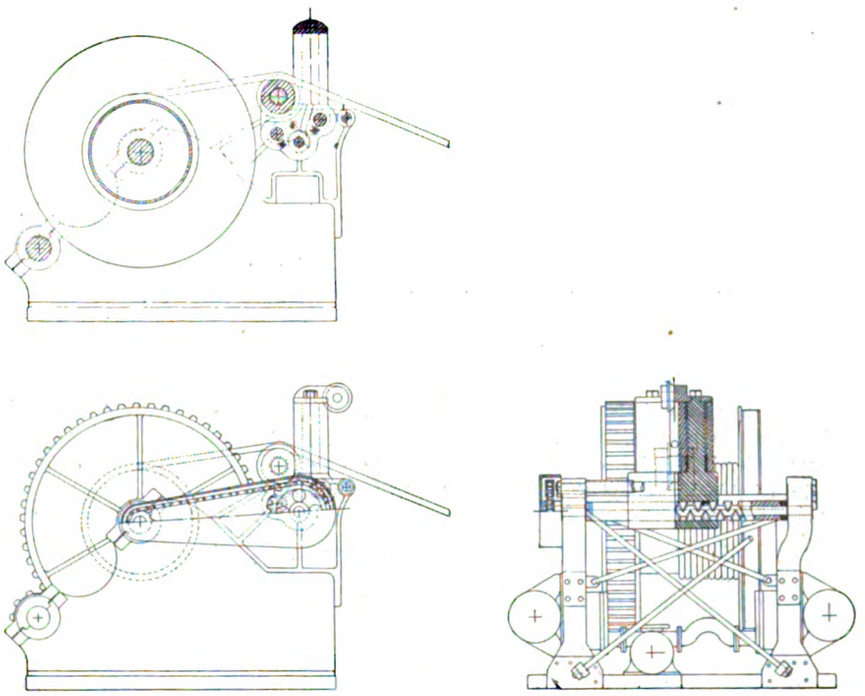


DIAGRAM OF DEVICE FOR AUTOMATICALLY WINDING THE HAWSER.

ANNUAL REPORT OF CRAMPS.

The annual report of the Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, for the year ended April 30, 1906, shows net profits of $704,724. During the year $370,972 was added to surplus. The balance sheet shows assets of $16,562,248 against $16,385,689 in the preceding year. The total surplus is placed at $3,264,265 against $3,072,357 last year. In his annual report President Harry S. Groves says:

"In submitting this statement to the shareholders of the company, I wish again to call their attention to the extremely unsatisfactory condition of the ship building business in the United States. This condition is due to the small volume of business offered and the number of yards competing therefor. We have been fortunate in securing a large share of the important contracts. Entering the fiscal year under review there were ten vessels yet in various grades of completion, of which three were for the United States navy. It is gratifying to be able to state that all the six vessels completed during the year were delivered promptly within the time provided in the contracts. In fact, two of these received a premium for anticipating the contract date."

TRIP OF A CHINESE JUNK.

The old and great Chinese junk, Wang Ho, has just arrived safely at Port Los Angeles, Cal. This is the famous vessel that was purchased recently by H. E. Huntington, the Los Angeles railroad magnate, and brought across the ocean from the Orient for exhibition purposes off the coast of California. The Wang Ho is the first vessel of exclusively Chinese build to cross the Pacific. This vessel is about 200 years old, and was used for more than a century in driving pirates from the shores of China. She is built principally of teak wood, and is a curious specimen of marine architecture. At her helm was Capt. Hans Bort. She was 70 days in making the long passage, and encountered no rough weather.

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SCIENTIFIC LAKE NAVIGATION

By Clarence E. Long

OPPOSITE AND REVERSE ON THE COMPASS CARD.

You will also find by looking on the compass card that the number of points in each course is in *reverse* directions and also in *opposite* directions. For instance, we will take NE ½ N, which is in the first quadrant of the compass, the reverse of which in the third quadrant

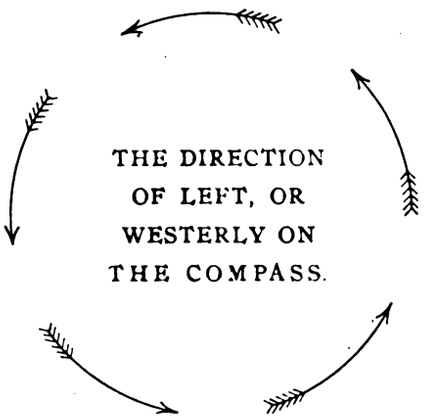
is SW ½ S, also a three-and-a-half point course, the same as NE ½ N. *Opposite* NE ½ N is NW ½ N in the fourth quadrant, which is also a three-and-a-half point course, and the reverse of this in the second quadrant, is SE ½ S, also a three-and-a-half-point course, and the opposite of this is SW ½ S, in the third quadrant. Do not get the terms "opposite" and "reverse" as applied to the compass, mixed up with each other. Mariners, generally, are a trifle out of their latitude on this seemingly "knotty" subject; but there is no reason for confusion, as there is a marked distinction between the two terms. The average person will use reverse and opposite as meaning one and the same thing in speaking of the directions on the compass, or horizon, as, "I can steer an opposite course with my compass," meaning a reverse course. They will tell you that NE is opposite SW, but this is not so. The opposite of NE is NW, but SE is the reverse of NW. For an example, we will take the sun. Now, the sun always sets in an *opposite* direction to that of its rising.

RIGHT AND LEFT AND EASTERLY AND WESTERLY ON THE COMPASS.

Right and easterly are one and the same thing when applied to the compass. Easterly has nothing to do with the east; it means to the right all the time, and you can start from any point, or degree on the card, and if you move easterly you will always go to the right. Right, or easterly, means the direction in which the hands of a watch revolve; or in the direction of the apparent motion of the sun around the earth, that is, across the sky from east to west, or from left to right. To move to the right around the circumference of the compass card, starting from north, you would have to go by way of east, thence to south, and from south to west, and from west to north. One point easterly of north, is N by E. Two points easterly of east is ESE; four points easterly of south is SW, and five points easterly of west is NW by N.

Left, and westerly, are just opposite to the foregoing. Westerly is against the direction in which the hands of a watch revolve, and has nothing whatever to do with west. Two points westerly of west would be WSW on the compass, and one point westerly of east would be E by N.

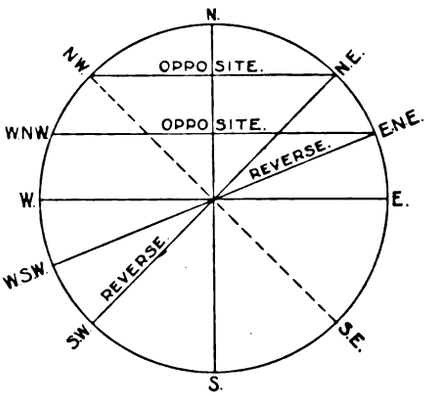
Do not get the idea that north is at the top of the compass and south at the bottom. If you were steering a vessel south you would find south at the "top" and not north. This comes from the fact that the compass diagram printed



on charts and in books, shows north at the top, but when you come to use the compass for navigating purposes, you will find whichever point you are steering on to be the top. In order to get this fixed in your mind correctly, you must imagine yourself situated at the center of the compass looking outward in every direction. Bear this in mind.

The scholar will see the importance of knowing the meaning of right and left, or easterly and westerly, as it is called on the compass, when he gets to correcting courses, that is, allowing for variation, deviation, current and leeway.

Note.—Knowing the correct meaning of the terms easterly and westerly, as applied to the compass, lies therein the whole secret of the application of the variation and deviation. Go no further until you have a clear understanding of these expressions. Most persons have a wrong idea of the meaning of these words, and the books on navigation are to blame for it. We know vessel captains that have studied the rules for applying the var. and dev. for years,



before they really got on to the meaning of the terms easterly and westerly, which in some of the books, are not called easterly and westerly, but just simply east and west.

We quote herewith from one book: "Variation is the direction the horizontal (magnetic) needle assumes when uninfluenced by external causes, is called the magnetic north, and at different times and places does not coincide with true north. The difference between these two directions measured in degrees is called variation. *It is said to be east when the north end of the needle is drawn to the eastward, and west when it is drawn to the westward of true north.*"

Now, this is partly correct, but not entirely so. It is confusing and misleading. Here the reason for the variation being named east, which should read easterly, is because the needle is drawn to the eastward of true north, and west, which should read westerly, because it is drawn to the westward of true north. This is very simple so long as north is made the top of the compass, but other complications set in as soon as you shift your position to the southward of the east and west points, and make south the top of the compass. If in the southern semi-circle of the compass 99 out of 100 persons will imagine the card drawn toward the eastward with east var. and toward the westward with west var., the same as with north. And why do they do it? Simply because the confusing rules in the books make it appear so. In the above case your easterly variation would be westerly and westerly would be east-

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erly. Easterly means to the right of any point or degree on the compass and it does not make any difference whether it be a point or degree to the north'ard of east and west or to the south'ard of east and west. Variation is named easterly, for one reason, because it draws, or pulls, the vessel to the right of all true courses supposed to be steered, and westerly variation is so named because it draws, or pulls, the vessel to the left of all true courses supposed to be steered.

Correct definitions are the first requisite in the books of navigation, without which the study becomes a burden instead of a pleasure.

Too much stress is laid on north as the reckoning point by many books on navigation, especially in explaining various rules and examples. North is a reckoning point, but not any more so than the point south.

In many books the var. and dev. are marked E and W, an abbreviation for east and west. This is incorrect. Var. and dev. should never be named E and W, it is easterly and westerly and the correct abbreviation is Ely. for easterly and Wly. for westerly.

Variation affects every point of the compass the same amount, at the same place and time, that is, if the var. is 5° Ely. it affects NE just as much as it does SE, south, or any other point on the compass. Easterly throws you to the right and westerly throws you to the left if not allowed for in the first place. When the variation is one point easterly, the whole card is swung around to the right just that amount. The result is that N on your compass is pointing N by E, N by E is pointing NNE, E is where E by S ought to be, S is pointing S by W, and so on all the way around. It does not begin to be puzzling till you come to south on your compass, which, with easterly variation, points S by W. But all that you have to remember is that with easterly variation, the card of the compass is deflected to the right just the amount of the variation and to the left with westerly variation, no matter which point of the compass you are looking over.

Variation is given on the charts and is always expressed in degrees, hence the importance of the student being able to convert degrees into points of the compass and vice versa.

Such questions as these would be very confusing and hard to understand were you not familiar with the terms easterly and westerly:

Start from east on the compass and move two points easterly, where will it fetch you? Answer—ESE.

Start from west and move three points westerly, where will it fetch you on the compass? Answer—SW by W.

Start from E by S and move 1½ points westerly? Answer—E ½ N.

Start from west and move 8 points easterly. Answer—N.

Start from SE and move 4 points westerly. Answer—E.

One point easterly of N is N by E; two points easterly of east is ESE; three points easterly of south is SW by S.

How many points is E to the right of W by N? Answer—Fifteen points.

How many points is W by N to the left of E? Answer—Fifteen points.

What point is 2 points to the left of south? Answer—SSE.

If your compass was affected by one point of easterly variation and you steered SE by it, what course have you really been making? Answer—SE by S, the compass being pulled to the right just one point, consequently SE is where SE by S ought to be.

Supposing that you desired to make good an SE course with one point of easterly variation, what course would you have to steer in order to do so? Answer—SE by E.

Such examples as are given above will be more fully explained in the lesson on "Correcting the Course."

PRINCIPAL KINDS OF LIQUID COMPASSES.

There are two kinds of liquid compasses—the Ritchie and the Baker. In the Ritchie compass the card is floated in diluted spirits of wine, which will not freeze in extremely cold weather. Spirits of wine is composed of 45 per cent of pure alcohol and 55 per cent of distilled water. The self-adjusting expansion chamber, by which the bowl is constantly kept filled, is beneath the bowl, and the two little holes on each side of the (base of the) pivot lead to it. This chamber is made of elastic metal, and counteracts the undue pressure caused by the changes in the temperature—expansion and contraction. You will find that the bottom of the bowl of a Ritchie compass is in two sections, the bottom part being screwed onto the main part. This forms a protection for the chamber, and being filled with lead acts as a weight in keeping the compass in an upright position, no matter how much the vessel is rolling or pitching. The bowl should be so completely filled by the spirits as to leave no air bubble. If one should at any time appear the bowl must be unshipped and turned on its edge with the filling-hole up, and the deficiency being made good through the filling hole, it is then closed by a screw cap and washer. If you ever have occasion to fill a Ritchie compass, use nothing but spirits of wine; if you were to use pure alcohol it would dissolve the enamel on the inside of the bowl, and also that on the dial, or card, or it would turn it a dirty brown. It is an easy matter to fill a compass if you go at it right. A small paper funnel (one that you can make yourself) is a handy thing for the purpose. Shape it long and slender with a fine hole at the pouring end. Place this end in the filling-hole of the bowl. Then pour the liquid into the funnel. The funnel will fill, but very little of the liquid will run into the bowl on account of the air pressure in the bowl caused by the tube of the funnel and liquid, preventing its escape. Now raise the funnel gently, and just enough so that the air can escape around the outside of the tube, between it and the filling-hole. When you have raised it enough to let the air escape, the liquid will start running. The tube part should be long and slender enough so that when the air escapes there is still a portion of the funnel in the filling-hole. This will prevent an overflow of the liquid by the escaping air. When all the liquid has run in that will run in through the funnel, there is liable to be a small bubble left. To expel it, get it directly under the filling-hole, so that when more liquid is run in the air can escape. When there is no chance for the air to escape the liquid will overflow—the liquid takes the place of the air. Sometimes the air does not escape entirely from the expansion chamber, and it will not be discovered until after the compass has been filled and placed in its natural position—face upward. If such proves to be the case another trial must be made of it. It is easily enough done, but requires patience and perseverance. There are other ways of doing this, explanations of which are given further on.

Should your compass show a leakage when outside, and no alcohol or spirits of wine at hand to refill it, use water for the purpose. The contents of the bowl can afterwards be run off and refilled with the proper fluid. In a seaway, an ordinary bubble in a compass will set the card swinging to such an extent that it cannot be used to steer the ship by. Should it happen to be an oil compass, instead of a spirit compass, kerosene oil may be used.

The Baker compass is filled with refined petroleum (benzine), and is called an oil compass. The card is made of paper and the inside of the bowl is covered with paper. The benzine has no effect on the paper, but if you were to fill one of these compasses with alcohol (and it has been done a good many times) it would warp the card to such an extent that the card would foul the under side of the glass and refuse to work. The Baker compass has the filling-hole and screw cap; also the bottom filled with lead, but is not provided with the self-adjusting expansion chamber, and for this reason air bubbles appear more frequently in this make of compass than in the Ritchie.

There are other makers of compasses, but Ritchie and Baker and Bliss are the

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principal ones in this country. Ritchie and Baker both hail from Brookline, Mass., and Bliss from New York. The Bliss compass is constructed very much on the same principle as the Ritchie.

The Axial-Balance Baker compass, a recent improvement of this make, is a very good compass. The improvement is in the magnet system of the card. The Baker compass does not contain the air-vessel to buoy the weight of the card and magnets as in the Ritchie compass. The card of the Baker compass is perfectly flat, and the depth of the bowl inside is not near as deep as in the Ritchie compass, nor is the bell metal pivot, which rises from the bottom of the bowl, as long as in either the Ritchie or Bliss compass.

The magnets of the Baker compass consist of flat, thin pieces of steel, instead of bundles of fine wire, as in the Ritchie compass. There are a number of them distributed over the card parallel to the north and south diameter of the card and on various chords parallel with this diameter. The six, or eight magnets together, are no larger or heavier than the single large magnet, first employed, or the three magnets afterward employed in the construction of compasses. In the three magnet system, one magnet coincides with the north and south on the card, and the other two are located on chords of 45° with this diameter. In the latest make there is less frictional error, owing to the fact that the weight of the smaller magnets is less, on account of their weight being distributed equally over (under) the card. In the larger number of magnets there is more directive force, or pointing power, due to the magnetic field being extended; also, that magnetism resides principally in the surface, and is greatest at the ends, or poles, of the magnets; hence, the more surface and the more ends with less weight and the same quantity of steel used for the magnets, the stronger the force, and the less the friction. By this principle it is possible to get more magnetism with less weight (friction) by the use of a number of magnets, than by a single magnet having more weight than a plurality of magnets.

In the Ritchie compass, the flange, or brass rim (the top of the compass) that holds the glass in position, and the rubber packing into place, is secured with machine screws, put in from the upper side of the flange, into the rim of the bowl proper, and come through the lip, or projecting rim of the bowl itself. In the Baker compass these screws pass up, from underneath, through the projecting rim of the compass bowl proper and into the flange and are not to be seen from the top. There is no advantage in this, more than for looks.

Gum-rubber packing, round in form, is employed to prevent the evaporation or leakage from a spirit compass. This rubber packing is about 3-16 of an inch in diameter, and it comes in long lengths, and it is put in and cut off at the desired length. It is not in one piece like a gasket, but the two ends are laid together. The packing is placed in between the glass cover and the edge of the bowl, that is, the glass is not laid on top of the packing, but rests in a groove, and the packing is laid around the edge of the glass. The flange, or rim, which is screwed to the top of the compass bowl and which holds the glass in position, has a circular ridge projecting below it. This ridge squeezes down on top of the rubber and tends to flatten it out, thereby filling the space between the glass and bowl and rendering it air tight.

Ordinary rubber packing cannot be used for this purpose, because the spirits have a tendency to dissolve it. The gum preserves the rubber.

The packing used in oil compasses is made of lead or tinfoil. No kind of rubber packing could be used for this purpose, as the oil would rot and eat it away. In the oil compass the glass rests on top of a lead gasket, and it is squeezed down by means of flange and screws.

To tell an oil compass from a spirit compass.—In an oil compass the magnets are exposed to view, that is, the bright and shiny steel needles are to be seen As a rule, these magnets are flat. The reason that the magnets in an oil compass are not covered is that oil prevents them from being rust-eaten.

In a spirit compass the magnets are sealed in watertight receptacles. If the magnets were exposed in a compass of this kind the water composition of the spirits would rust them and make them useless after a time. If you were to fill a spirit compass with benzine, the benzine would dissolve the enamel of the card and bowl and eat the rubber gasket.

If you were about to fill a compass having a leak you could easily tell by the smell of the liquid whether it be oil or spirits.

Every compass has a number. A Ritchie compass has its number stamped on the brass flange, or rim. The compass should be placed so that the number is on the for'ard side of the compass looking for'ard. Remember this, so that when you have occasion to place a compass you can do it correctly. There would be no trouble were there only one lubber point to the compass, but when there are four, as in all late makes of compasses, it would puzzle one were he not onto it. The Ritchie compass also has its number stamped on the rim of the bowl, directly under the number on the flange, so in case of having to replace the glass for a broken one or new packing for old, these two numbers should come together.

A Baker compass has its number stamped on top of the after end of the brass gimbal, or hoop, that the compass bowl swings or rides in. Remember this when setting a Baker compass in its binnacle, or in its place in the pilot house. A Baker compass usually has a fine white line painted on top of the black enameled rim, directly over the lubber point. This mark should always be on the for'ard side; also, the name is printed on the bottom, inside the bowl, and should read right side up.

You can also place a compass according to the position of its bearings, or by its bearing cups. The bearings attached to the gimbal hoop ride in the bearing cups attached to the side of the compass box or binnacle, and the compass should be placed so that these lead athwartships, or crosswise. The bearings attached to the compass bowl which ride in the bearing cups of the gimbal should run for-and-aft, or lengthwise. In either case the number of the compass will come right side up. Remember this.

CARE OF COMPASSES.

Never tamper with the glass top of a liquid compass.

When unshipping a compass from its binnacle, if the compass has more than one lubber's point* (some have two and some have four) be careful to note which was for'ard, and when putting the compass back into the binnacle, see to it that the same lubber's mark is in the same position. This will prevent any error in case the lubber's marks are not all correctly placed. The compass bowl, when it is in the binnacle, should hang perfectly level. If it does not do so it may be made to hang level by winding a little lead wire around the gimbal rings. Before doing this see that the straps over the bearings of the gimbals do not bind. If the card of a dry compass is not balanced, a drop or two of hot sealing wax in the proper place on the under side of the card will remedy the evil. When a liquid compass is packed for transportation, the bowl should be taken from the gimbals and placed in a box face down (compasses packed for transportation by Ritchie are invariably face down) and excelsior packed tightly all around it; place the gimbals in a box with the bowl, but pack them so that they will not touch the bowl. If possible, transport the box in a position so that the face of the

**Lubber's Point.*—The lubber's point is the vertical black line painted on the inside surface of the compass bowl, and represents the vessel's head and the line of the keel. The center of the compass card and the lubber's point should be in a line with the keel of the vessel, and the point marked on the card representing the course the vessel is to be steered should be kept coincident, that is, the vessel's course and lubber's point should always coincide.

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compass will be down. Compasses should be laid up for the winter in this manner, or when not in use. Care should be taken to keep the compass, either while being transported or stored, away from magnets, or large masses of magnetized iron, to prevent the compass needles from losing magnetism. The compass should never be placed where it is liable to be heated to 300 degrees Fahr. Extreme heat has the effect of decreasing the magnetism in magnets. In carrying a compass hold it face down.

It ofttimes occurs that there is too much end play between the bearings on the gimbals; also the bearings on the compass and the ends of the bearing cups in which they ride, thus causing the compass to hang out of plumb. Whenever this occurs small wedges of sheet brass or copper should be made and placed so that there will be the same amount, or number, on the for'ard as on the after side, and on the port as on the starboard side. This will bring the compass bowl directly in the center of the binnacle and in the center of the gimbal hoop, causing it to hang level. This will occur when the binnacle is too large for the gimbal and the gimbal is too large for the compass bowl. Where there is too much play the compass will slide so far for'ard or aft, or to one side or the other, that the compass bowl will be so much out of level that the edge of the compass card will tip up and foul the glass and render it useless.

The Baker compass is so arranged that these adjustments may be made by merely tightening up on the bearings, which are secured on the ends by set screws. This is a very handy and convenient arrangement.

The student will probably wonder why compasses are marked with four lubber-lines or points. There is no good reason unless it facilitates the placing of it in the ship for steering or navigation purposes. In placing the compass according to the amidship fore-and-aft-line of the vessel, either to coincide therewith or to be parallel thereto, it should be lined up from the lubber point, and not from the box or binnacle. For this purpose four lubber points cannot fail to be a good thing. Of course, only one is used to steer by. Of course the lubber points must be accurately drawn. To test this, set the compass to any reading, say due north, then see if east, south and west coincide exactly with the remaining lubber points. Be sure to face each lubber point squarely to prevent parallactic displacement.

Captain Lecky says there should be only one lubber point, and never more than three. The after one should not be placed, to avoid mistakes in reshipping the bowl, when temporarily removed from the binnacle for any purpose, also to prevent the possibility of reversal in the gimbals. The student will experience no difficulty from this source if strict attention be paid to what has already been said about the placing of compasses according to number and the position of their bearings. The fore-and-aft bearing (to counteract the roll) should line up fore-and-aft, and the athwartship bearing (to counteract the pitch) to line up athwartships.

Four lubber points accurately placed are handy to draw lines from for the placing of magnets in compass adjusting.

In putting the Ritchie compass together see that the two zero marks come on the same side. One is stamped on the bearing of the compass and the other on the cup bearing of the gimbal.

THE STEERING COMPASS.

The steering compass is that particular compass set in a case known as a binnacle near the steering wheel and is the one by which the wheelsman guides the vessel on any desired course, or is the one which assists the man at the wheel in keeping the vessel's head in the prescribed direction.

The best compass for this purpose is the one in which the card is almost floated in liquid. This is a form of compass that has an air-vessel attached to the card to relieve the weight of the card and its appendages on the pivot, and a self-adjusting arrangement in the bottom of the compass bowl, which permits, without injury to the several parts, the expansion and contraction consequent on change of temperature.

The steering compass should be a liquid compass of reliable make, with a card 7½ in. in diameter, graduated to degrees as well as quarter points, and possessing the same qualities in smooth as in rough weather. In steamers (which do not yaw badly in a heavy sea) courses should be steered to degrees; practically greater accuracy is obtained by steering to degrees, and courses to degrees should be taken from the chart.

Note.—A compass with a card 7½ in. in diameter makes a good steering compass for small vessels, that is, ordinary sized vessels, but for large vessels there is nothing better than the Ritchie compass with a 9-in. dial, both for standard and steering compasses. A compass of this kind must be of late make and pattern, that is, short-needled and from 6 to 8 magnets (bundles of steel wires*) laid parallel to one another and equidistant on the bottom of the card.

*The magnet system consists of bundles of steel wires, the wire being .06 in. in diameter, laid side by side with each other and magnetized as a bundle between the poles of a powerful electro magnet; they are afterwards placed in a cylindrical case, sealed and secured to the card. The series of steel drawn into the wire is more homogeneous and for the same weight gives greater magnet power than the solid steel bar.

Some will probably not agree with us on this point, but we have found it so from practical experience. Small compasses (6½ to 7½ in. in diameter of card) have been found in a seaway to be entirely worthless, unfit and unreliable for safe navigation. This is especially so in steel steamers.

According to the old idea the compass should not be more than 7½ in. in diameter, and this was good logic for that time, because at that time the needle was always made the same length as the diameter of the card and 7½ in. was the limit in length, that is, this length of needle was found to give the best results. The magnet system then consisted of a single needle, or bundle. Some makes of compasses had only the single flat steel magnet, which was as much as half an inch in width and an eighth of an inch in thickness. But compass makers have learned a few things since those times. It used to be the longer and the larger the compass needle the stronger its directive qualities, and consequently a larger card could be employed. The large card enabled the wheelsman to steer to degrees more easily, because the space between the marginal divisions, or graduations, was so much larger than the smaller card, hence more discernible.

On many of the ocean passenger steamers of not so many years ago, the needles in the compasses were from 12 to 20 in. in diameter. They were made in this manner to gain steadiness, but which resulted in sluggishness. The chief object in the employment of large compasses is to enable the wheelsman to steer to degrees, and a more accurate course is presumed to be preserved. With reference to the increased size it must be observed that competent authorities limit the length of efficient compass needles to 5 to 6 in.; beyond this limit an increase of length is accompanied by an increase of directive power in the same proportion, and if the thickness of the needle be preserved, the weight, and consequently the friction, increases in the same ratio. No advantage of directive power is therefore gained by increase of length, but with the increased weight of the card and appendages, the increase of friction probably far exceeds the increase of directive force; sluggishness is the result, which is further exaggerated by the extreme slowness of oscillation of long needles compared with short ones. Large cards, however convenient in practice, are, therefore, not without danger, for the course steered may deceive the seaman by seeming right to the fraction of a degree, but which avails little if the card itself is wrong half a point, and the vessel in consequence hazarded.

The question then was stated as follows: The smaller the card (needles)

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the more accurately it points; the larger the card the more accurately it is read.

This is still true, so far as the length of the needles is concerned, but not so with the size of the card. In late years the above law has been slightly modified, and from it better and more favorable results obtained by the use of short needles attached to large cards. By this arrangement the advantages of a large card, having large marginal divisions to steer by, are secured without the drawback of long needles, which are objectionable for more reasons than have already been given. This law was founded upon a peculiarity of magnetism. It is a fact that magnetism resides principally in the surface, and is greatest at the ends or poles of the magnet. According to this, then, there is no loss of magnetic force consequent on thinness, as it is principally on the surface where this force resides.

Therefore, the more surface you have the greater and wider the magnetic field, and the more ends or poles the greater the magnetic power. The two together are essential requirements of a first-class navigating compass.

To illustrate these principles more forcibly, we will take two pieces of steel of equal dimensions, say 6 in. long by ½ in. wide and 1-16 of an inch thick. We will leave one as it is and the other we will cut up into eight slender bars, each 1-16 of an inch in width and thickness and 6 in. in length. Temper and magnetize all alike, and to one not familiar with the laws of magnetism there would seem to be the same amount of magnetic force in the one large piece as there is in the eight pieces put together. But, is there? No, there cannot be, because in the eight pieces we have more surface and more ends than in the one single piece, and this is where the magnetism is greatest. It is a fact that the eight slender pieces will possess several times more magnetism than the one large single piece.

Compass manufacturers took advantage of this law and are now making compasses accordingly. The eight pieces have the same weight as the one piece, but the eight pieces possess a greater amount of magnetic force. So from this you can readily see that it would be possible to get the same amount of directive force from several of the slender magnets, used in conjunction with each other, with less weight, than with the large single magnet alone; also a wider magnetic field would be possible, because with the several magnets it is possible to distribute them equally over the plane of the compass card, whereas this would be impossible to do with the single magnet. From this it follows that in all compasses the needles should be very thin, and that there should be a plurality of them—the less weight the less friction. The weight of a plurality of magnets is now equally distributed underneath the surface of the card, which could not be done by the use of a single magnet.

Compasses constructed according to the above principle could be used to advantage if the size were increased from 9 in. to 12 and 15 in. Some compass makers claim that there is no advantage gained in diameters over 9 in.

The shorter the compass needles the better, so long as they are able to do their work. There is, of course, a limit to the length of the needles, corresponding to the diameter of the card. It would necessitate that a direct proportion exist between the two.

In most lake steamers the steering compass sits in its box on a wooden shelf, or stand, near the steering wheel. On one side there is a sliding binnacle lamp, to which is attached a brass or copper funnel to throw a ray of light on the lubber point of the compass, which enables the wheelsman to steer in the night time. By this arrangement the light only shines on the point to be steered, and not all over the face of the compass. If the light were so fitted as to show all over the compass it would prevent the wheelsman from seeing out ahead of him.

MOUNTING THE STEERING COMPASS.

Steering compasses should be placed according to the requirements of the vessel, and as much consideration as possible should be given to lessen the iron near the compass. All stands for the engine room indicators and bell or whistle pulls, as well as tubes or castings in which they work, should not be of iron, but of brass, and if there be a steam coil in the pilot house the tubing should be of brass or copper (there is never any magnetic attraction in brass or copper, i. e., neither of them have any influence on the compass needle). It is also very important that sash-weights for windows should not be of iron. (It is most likely that some of our readers have had experience with iron window weights influencing the compass, if so, they will be able to appreciate the statement just made.) We know of cases where these weights have drawn the compass out fully two points. Many boats have done away with these sash-weights altogether, and are better for it.

The steering compass should always, if possible, be mounted on the amidship fore-and-aft line of the vessel, at a neutral point as far as circumstances will admit, and with its lubber's point in the fore-and-aft line. If the compass is not mounted so that an imaginary line drawn through the pivot and the lubber's point will be parallel to the line of the vessel's keel, the steering will not be correct. Where there is more than one lubber point, as in a majority of cases, an imaginary line drawn through the fore-and-aft marks will amount to the same thing.

Where, from inconvenience, it is necessary to place this compass on one side or the other, as is often the case where the steam steerer is in the pilot house, or where the hand-power steering wheel is large, the error due to what is technically known as parallax (looking at the compass in an oblique direction) causes an apparent change in the relative positions of the lubber's line and the marginal divisions of the card, amounts to a marked consideration, and often leads to disaster. The greater the space between the edge of the card and the side of the bowl, the greater this error will be. Unless the wheelsman can get the center of the card and lubber-point in one with his course, he is sure to steer to one side of it. This parallactic displacement of the lubber-line frequently amounts to as much as a quarter of a point. In the run from Chicago to Pt. Betsey (203 miles) this would make a difference of 10 miles at the end of the course, a serious consideration in thick weather.

It is of the utmost importance to have the steering compass directly facing the man at the wheel, and as far distant from him as may be compatible with distinct vision. The diameter, then, of such a compass in large vessels ought not to be less than 9 in. If constructed on the short-needled principle, there would be a great advantage in increasing the size from 10 to 12 in. if not more. The steering compass should be placed as far for'ard as possible, especially so if there be any iron in the make up of the steam steering gear, all of which is powerfully magnetic.

This is also true of sailing vessels where the compass is often placed within a foot or so of the iron spindle of the steering apparatus, and it is usually in about the same plane. By placing the compass as far for'ard as possible, it is less within the influence of the iron spindle, tiller, rudder-head and stern-post.

The compass needle should be at least 3½ feet from the iron deck beams and as much higher as can be made convenient to the wheelsman, always avoiding vertical iron as much as possible. The reasons assigned for mounting the compass as hereinbefore described will be hereafter fully explained in the Deviation of the Compass, and in the subject of Magnetism, at which time the student will be sufficiently advanced to appreciate the logic for such reasons.

The steering compass should be substantially mounted, and securely fastened in the place selected for it. The best "rig" for this is a four-sided wooden box or stand, a little larger in width than the compass box itself. This stand

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or binnacle should be from 3½ to 4 ft. in height, and it should run from the pilot house floor up. Its sides should be perfectly square, and a shelf piece put on the top end for the compass to rest on. Draw perpendicular fore and aft lines and perpendicular athwartship lines up its four sides to coincide with its center. The compass should then be fastened to the top of this shelf piece so that its lubber-lines coincide with the lines drawn on the side of the binnacle box. The binnacle should be set plumb to coincide with the fore-and-aft line previously drawn on the pilot house floor, and there securely fastened. The lines drawn on the binnacle box will be found convenient for placing magnets in adjusting the compass. To prevent vibration from the machinery and the motion of the boat, fasten the binnacle with wooden or brass brackets. These should be fastened near the top of the binnacle box. Be careful about lining up the compass. Be sure and get its lubber lines to coincide with the fore-and-aft line of the ship, or parallel thereto.

Some important cautions may be given here:

See that the wheelsman faces the compass squarely and not obliquely.

Never oil the bearings of a compass. Keep the dust and dirt out of the bearing cups, and see to it that the bearings work freely, and that the bearing straps do not bind.

Be sure that the binnacle lamp, if one is used, is made of brass, or some other non-magnetic material. Also the funnel conveying the light on the lubber-line of the compass. Keep all iron and steel as far from the compass as possible, likewise anything made of tin or zinc, as these are very strong attractors. See to it that there are no stow-holes or lockers near the compass, where iron nails, screws, bolts, etc., can be thrown and allowed to remain.

Do not leave your pocket knife lie around near the compass, nor your tin tobacco box, if you have one.

If you have a tin megaphone keep it out of the pilot house, also away from the standard compass.

LAKE COMPASS EQUIPMENT.

None but those who have attempted to do such work can tell how perfectly inadequate is the compass equipment on lake vessels for finding compass corrections, taking bearings, etc.

We do not hesitate in making the statement that if a proper system of inspection of compasses was an accomplished fact, that 75 per cent of the compasses in use on lake vessels would be at once condemned as totally unfit for reliable navigation, brought about, first, by their bad position; secondly, by their inferior quality, and, lastly, by their false adjustment.

As a rule, the compasses of our lake vessels are boxed up in the pilot house, from which no observations whatever can be made for bearings of objects from the vessel.

Where courses are changed often, as in lake navigation, it is advisable to mount the standard compass on top of the pilot house, where it is accessible at all times to the officer on watch, and is least obstructed from an all around view. The binnacle should be placed far enough from the edge of the pilot house to permit taking bearings in every direction; it should also be so far from the steering compass that the magnets used for compensating the standard compass will not influence the steering compass. A good many boats carry their standard compass in this manner, but there are a great many that have only the steering compass. One compass is insufficient for the safe navigation of any steamboat. Other steamboats have their standard compasses located on top of the texas. This is a very inconvenient place for it, inasmuch as it is necessary for the navigating officer to make a trip from the top of the pilot house to this compass every time it becomes necessary to look at it. On this account little or no attention is ever paid to this compass, and just for this reason.

Other steamboats carry their standard compasses on the forecastle deck. This is a bad position for such a compass, as it is not accessible to the officer in charge, who stands his watch on the bridge (or he ought to if he does not), and it is also nearer to the ship's magnetism and consequently more deviation exists. This compass should be right under his nose, so that he can look at it at any moment. In thick or foggy weather, meeting steamers, it is absolutely necessary to have this compass on the pilot house, so that he can get the bearing of fog whistles, both in meeting and passing vessels, and in entering port in thick weather or on dark nights; also in changing the course from bearings of fog whistles in thick weather. Where the standard compass is not located on the pilot house the navigating officer has to depend entirely on the wheelsman to take bearings, and to give the course the vessel is heading on at the time. If the wheelsman makes a mistake, the captain or officer, in charge has to shoulder it. A good many boats have gotten into trouble in more ways than one, and their officers put out of good billets for this simple reason.

It is a very important feature to have this compass located on the pilot house in the matter of setting courses, and for the officer of the watch to keep track of the steering. Where the standard compass is not accessible to this officer he again has to depend on his wheelsman for the whole thing. It is an easy matter to make a mistake in a course, especially in misunderstanding it when it is given by the officer to the man at the wheel. For instance N by W for W by N. Both sound alike, but are no more alike than black is like white. With the standard compass placed on or near the bridge this could never happen.

In the matter of looking after the steering of a boat, where the standard compass is at all times in view of the watch officer that gentleman can look at it every time he walks back and forth on the bridge, and check up the wheelsman every time it becomes necessary. Some wheelsmen will let their boat work all on one side of the course instead of evening it up, that is, as much on one side of the course as on the other.

Where there is only one compass the man in charge of the deck should go into the pilot house occasionally to see that she is on the right course. Where there is only one compass wheelsmen are not apt to be as careful as when they know their steering is being watched and compared by another compass.

Where there is only the one compass the deck officer can watch the steering by getting the bearing of some object ahead, or by the vessel's wake, or by stars in the night time. Where the compass works loggy and sluggishly, the steering in the night time (clear weather) is done by getting some star ahead that is in line with the vessel's course. It must be borne in mind that the stars keep shifting their bearings at short intervals, hence the course steered in this way could not be depended upon for any length of time.

Too much attention and care cannot be given to these matters if you wish to take your vessel in safety from one port to another.

There is no advantage whatever in having a large number of compasses in a vessel, since, unlike the mean results of a number of clocks or watches, for example, the mean results of any number of compasses need not necessarily be near the truth, as they may all be largely affected by deviation and the deviation may be all in one direction. Hence, the necessity of depending on one compass alone, but that compass should be in the best position in the vessel, of the best manufacture, and the constant attention of the navigator should be devoted to ascertain its deviation.

There is a very common error prevalent respecting the best position of the vessel's deck for a compass, such as the standard compass. Some of the earliest writers lay it down as an axiom that

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on the deck of all iron vessels there is a neutral point which should be sought out for fixing the compass. That an apparently neutral point does exist is admitted. But this same point is very frequently a most dangerous position for fixing a compass. It is neutral only when the vessel is in the same locality.

It ofttimes occurs that the fittings of the steam steerer are not made of brass, as they should be. This is especially true of the shafting of the steam steerer. We know of cases, in new boats, where the spindle of the wheel and vertical shafting communicating with the steam steering engine were made of steel, though their ends were less than a foot from the compass. As soon as it was discovered by the captain and the compass adjuster, it was at once reported to the builders, and after a good deal of wrangling on both sides of the house, the shafting and spindle were taken out and brass ones substituted therefor. It was a hard matter to convince the builder of the importance of having these connections made of brass. He could not see what difference this would make, and thought this could be allowed for when the time came for adjusting the compass. The builder even went so far as to intimate that if the adjuster knew his business he could have made a job of it as it was.

We know of cases where the shafting alluded to was inclosed in a brass pedestal, which concealed it most effectually. In one instance the attraction was so great from this piece of vertical shafting that the compass remained at one and the same reading, no matter in which direction the vessel's head was turned.

How to purchase a new compass, and the test it should be given, is explained in the lesson on Magnetism.

Compasses needing repairs should be sent to their makers, not to some ship chandler's store, unless you desire them to send them in for you. The manufacturers have all the facilities for doing this kind of work, and it will cost you less in the long run than to give it to some cheap John who offers to do it for less money than the charge made by the maker. The maker usually charges $5.00 for overhauling a compass, and when it comes back it is practically as good as new. In addition to this charge there is the charge for expressage both ways, amounting to about $3.00. When a compass becomes slow and works sluggishly it should be sent at once to the manufacturer and the defective parts repaired. A compass wears out the same as any other piece of fine mechanism, though some people have an idea that they never do. Not half enough attention is paid to this invaluable and wonderful instrument, when one considers the constant service it renders.

If, when ordering a compass from the dealer, or manufacturer, it be desired to have a degree division marked on the circumference of the card, in addition to the points and quarter points, it must be so specified, otherwise they will send the plain card. There is no difference in the cost.

Some cards are divided into eighths of a point. This arrangement is all right for large compasses, but steering to degrees is much better, where it can be employed. Putting the eighth points on the card comes extra.

THE STANDARD COMPASS.

The standard compass, which for all practical purposes, is termed the navigating compass, merits unusual consideration. It is of the greatest importance that a spot should be selected for the standard compass where it would only be acted upon by the general magnetic character of the ship, and not by particular masses of iron in its immediate vicinity. In large sea-going steamers a special platform is erected, and is sometimes reached by a ladder. In most lake steamers the standard compass is placed on top of the pilot house. The binnacle in which it sits should be securely bolted down to the deck, so that the vibration of the engines will not destroy its steadiness. There should be no iron whatever on top of the pilot house; all fittings, hand-rails, etc., should be made of brass. Like the steering compass the standard should be a liquid compass, not less than 9 in. in diameter, well balanced, sensitive in smooth and steady in heavy weather; or a dry compass with a card 12 to 15 in. in diameter and possessing the same qualities. Either liquid or dry compasses should be from some reliable maker. The compass should read to degrees in addition to the quarter points. The standard compass should be fitted with an azimuth circle* for taking bearings of the sun for azimuths. The standard compass binnacle should be of bronze or brass, and should be fixed in a permanent position, raised at such a height (not less than five feet) as to permit an all around view of the horizon, so that bearings of the land may be conveniently observed by the compass set within. The best binnacle for this purpose is the patent compensating binnacle, which admits of the adjustment being done by placing the magnets inside the binnacle instead of placing them about the deck, exposed to weather and wear and tear.

This is a neat and compact arrangement, and access to the interior can be had through a small door provided with a good patent lock and key. To prevent tampering with the magnets, or the inside be made use of as a handy stowhole for odds and ends, the door should be religiously kept locked and the key in the possession of the captain.

One of the great advantages of this plan is that when it becomes necessary to remove the binnacle for any purpose—such as caulking deck, recanvasing, etc., there is no occasion to disturb the magnets; whereas when they are nailed to the deck round about the binnacle it will sometimes happen that they are taken up by some one ignorant of the mischief they are doing; and when replaced—as likely as not the magnets are shifted end for end, and put down again at a greater or less distance from the compass than they occupied formerly.

*The practice now prevails of taking bearings by means of a dumb compass card, called a Pelorus. This answers the purpose admirably. As will be seen hereafter, they can be placed in any part of the vessel for observing objects of all kinds. The Pelorus and its use is explained in another lesson.

TRADE NOTES.

The Whiting Foundry Equipment Co., Harvey, Ill., have just put out their latest crane catalog containing 162 pages illustrative and descriptive of electric travelers and cranes of all types. There are over a hundred illustrations of crane installations in foundries, machine shops, railway shops, and ship yards, including besides the electric travelers and hand power cranes, numerous jib and bracket cranes, pillar cranes, gantry cranes, transfer cranes and special derricks for railroad and marine service. The catalog is printed in two colors with an attractive cover and is carefully indexed. It will be sent to anyone upon request.

The Sur-Coat Manufacturing Co., 149 Jefferson Ave., Detroit, have put on the market a boiler compound of more than usual excellence. The company has a number of excellent testimonials from concerns that have used the compound speaking of it in the highest terms. It also has on exhibition some samples of scale removed from boilers, which show the extraordinary thoroughness of the compound in doing its work. The compound is shipped in a dry state, thus saving freightage on water. The company's testimonials have been reproduced in facsimile form and will be sent to anyone interested, upon request.

The steamer John R. Stirling, formerly the Vanderbilt of the Western line, has been transformed from a package freighter into an excursion boat at the yard of Abram Smith & Son, Algonac, Mich. She has left the ship yard for Chicago, where she will be operated by Capt. George Tebo.

The repairs to the schooner Annabell Wilson have been completed at the yard of Abram Smith & Son, Algonac, Mich.

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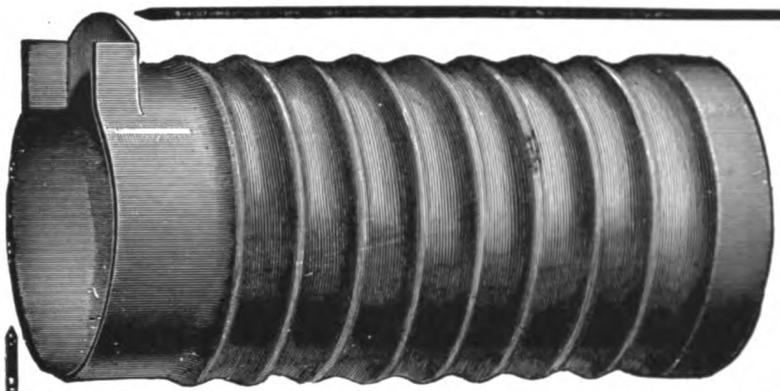

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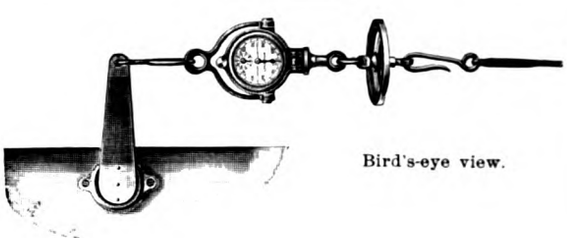

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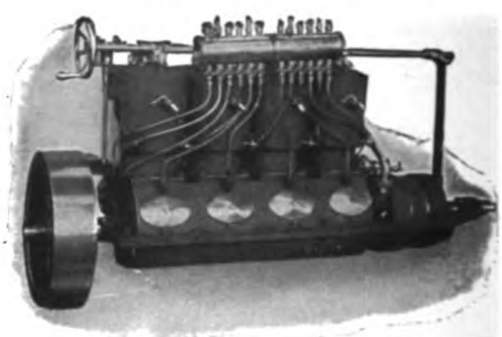

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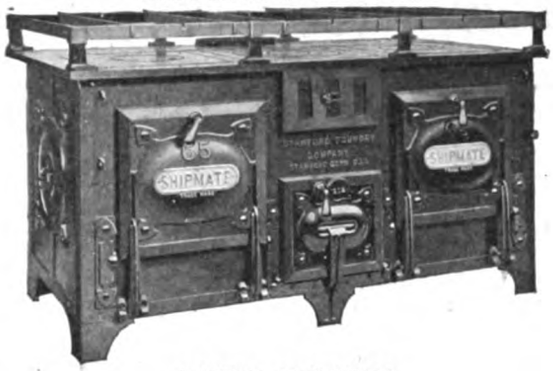

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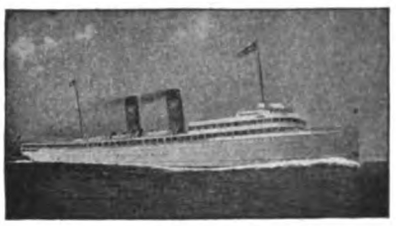

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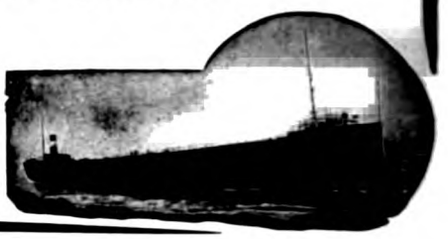

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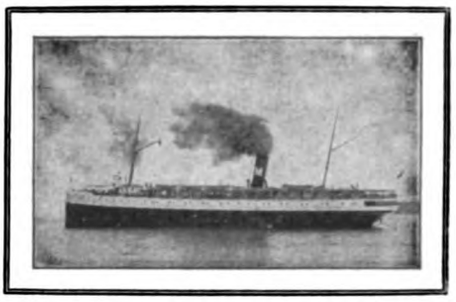

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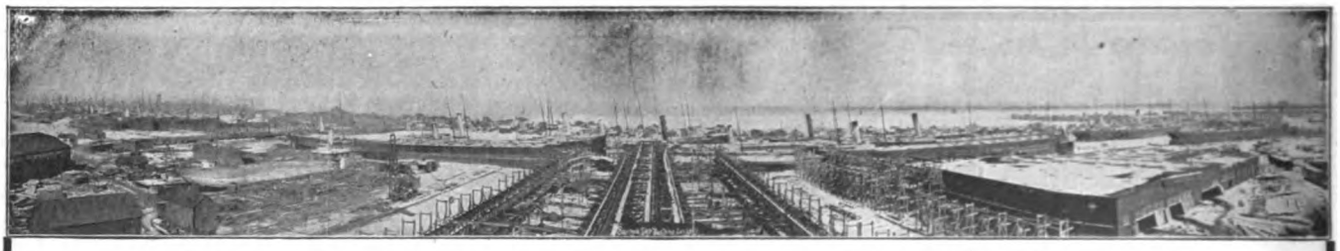

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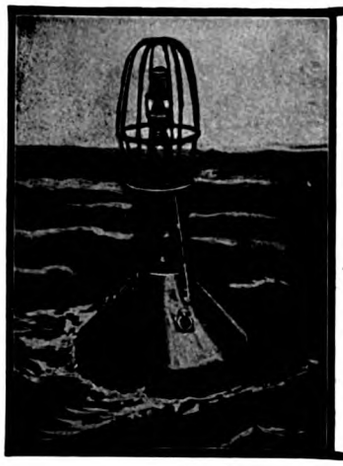

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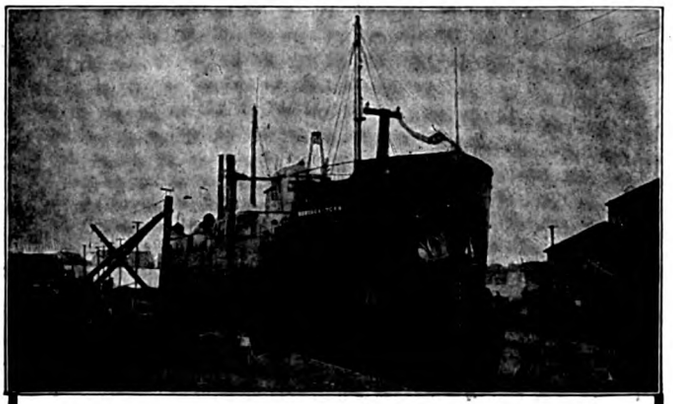

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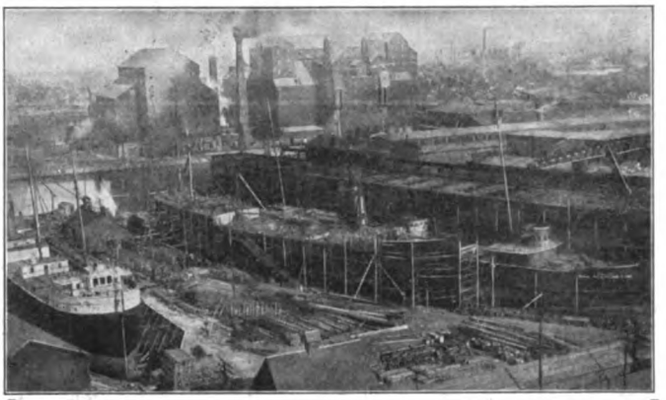

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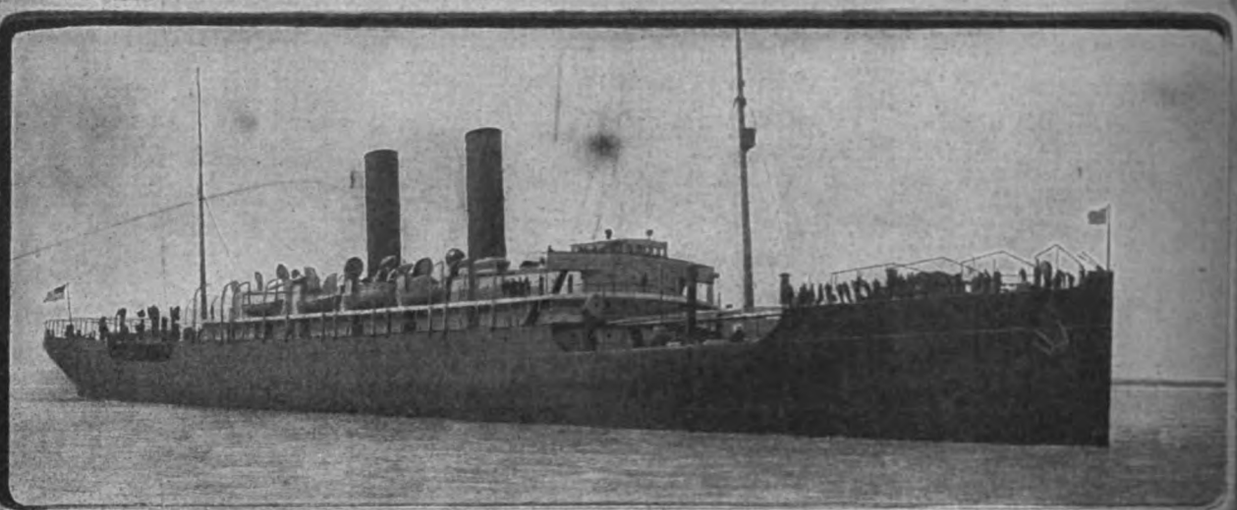

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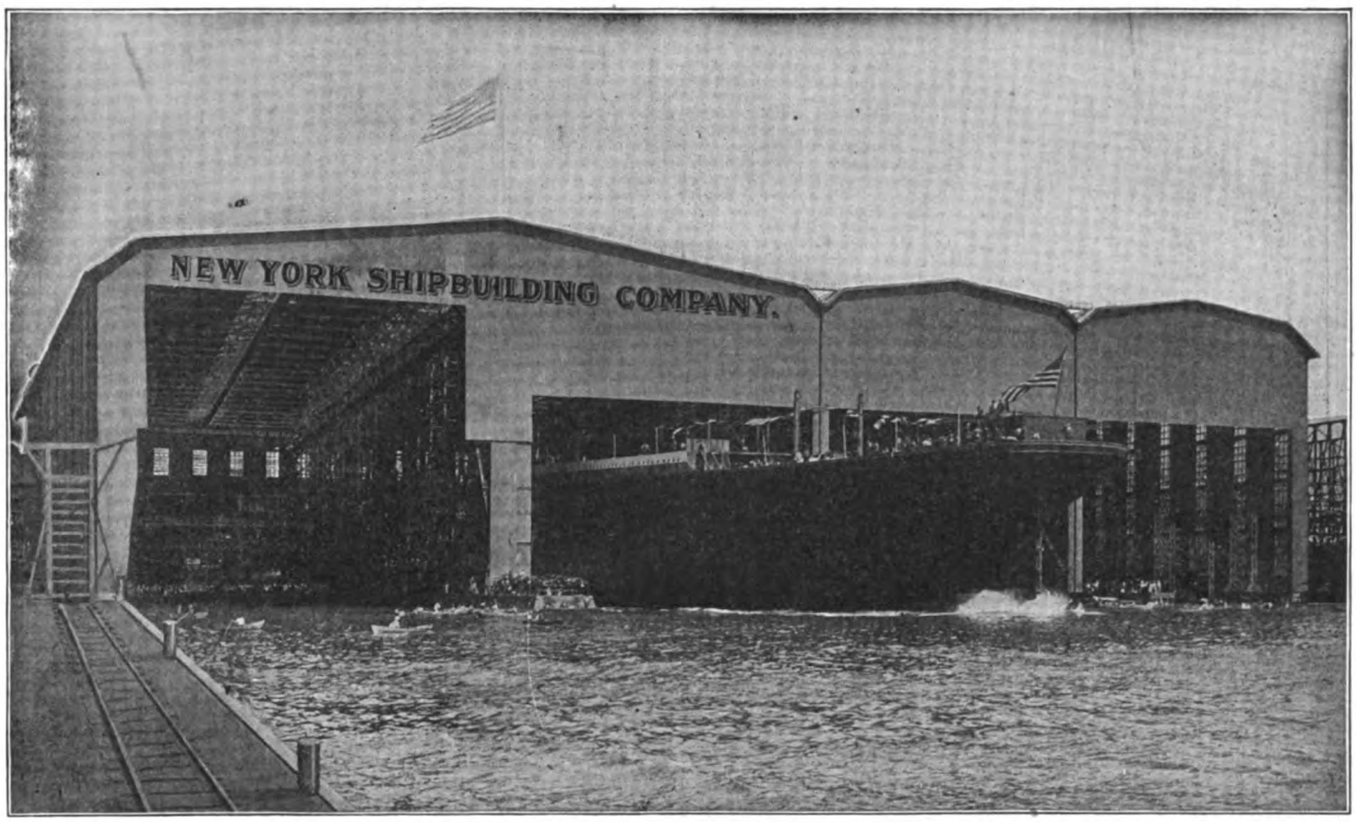

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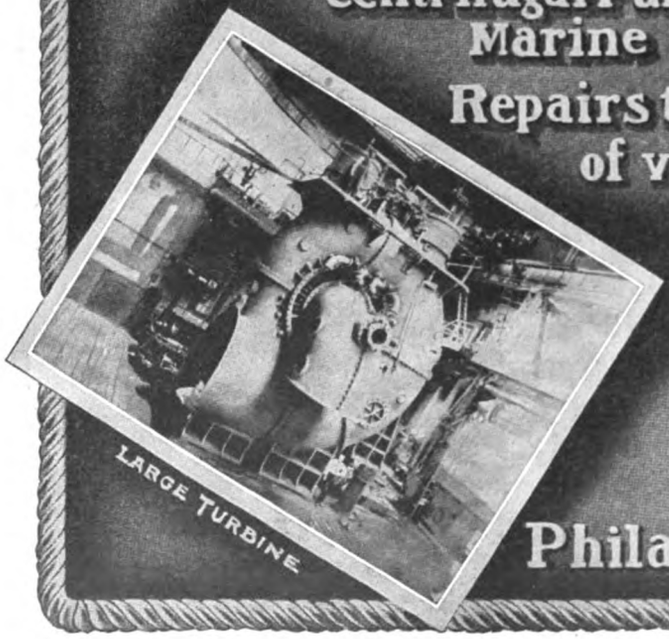

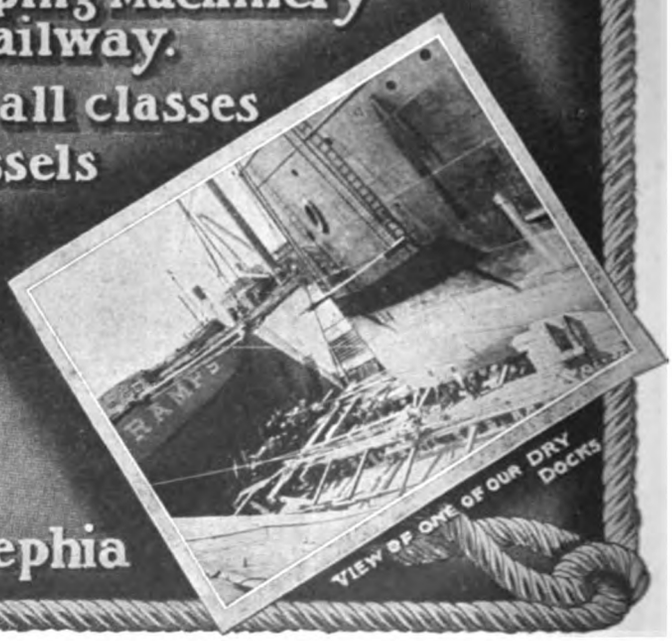

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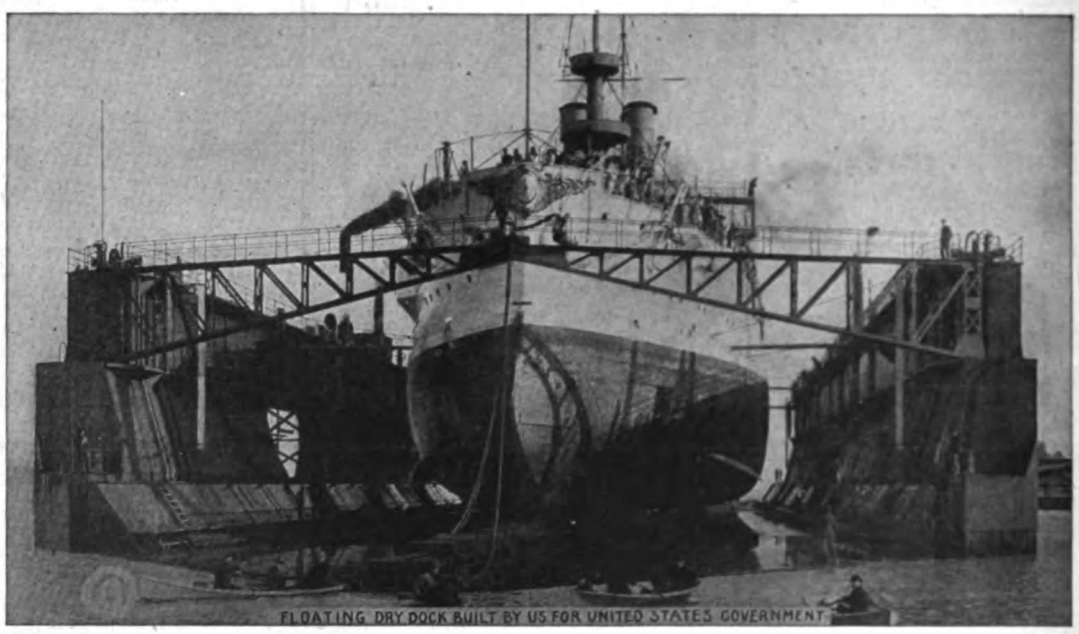

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Guaranteed to give perfect satisfaction.

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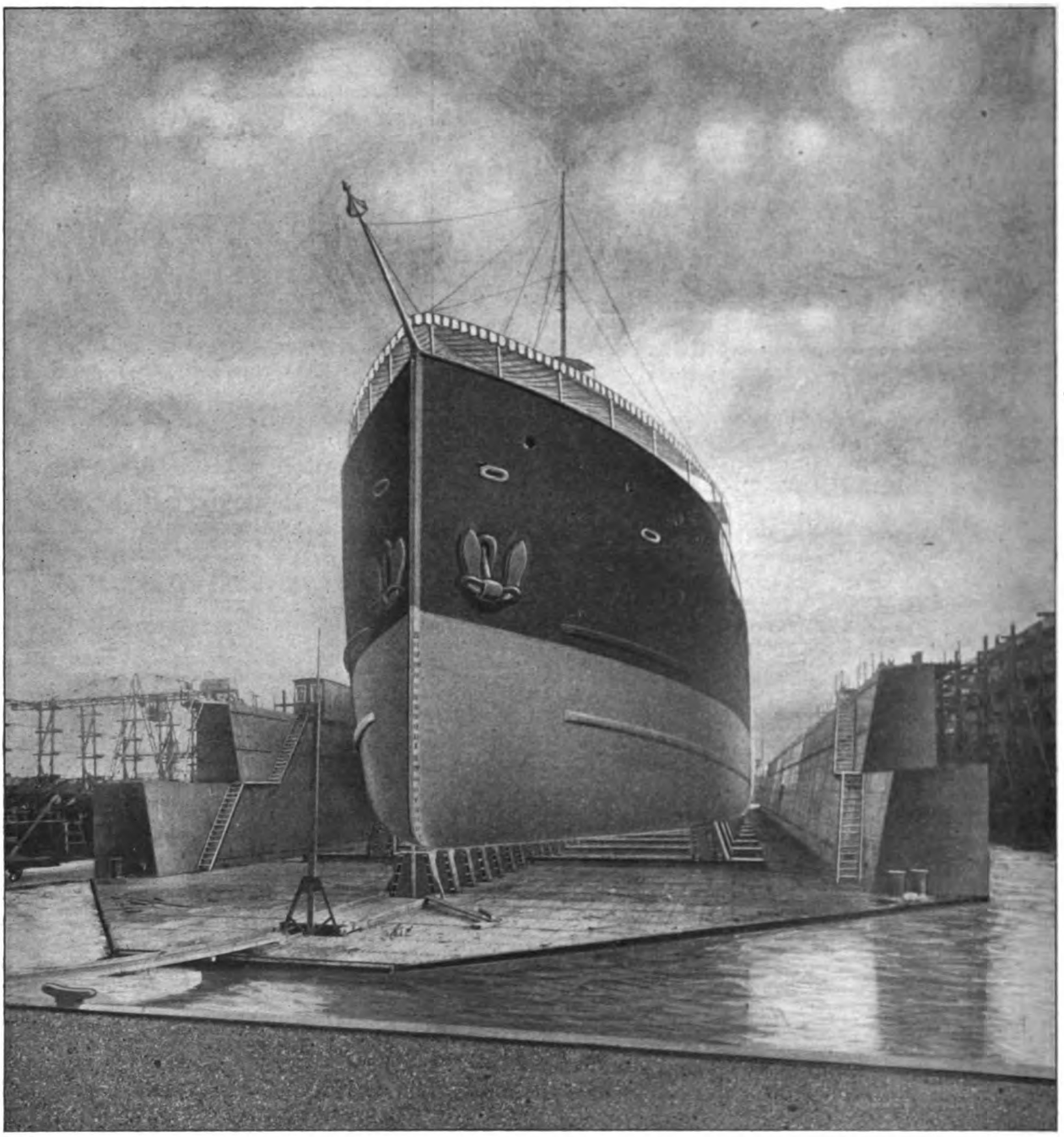

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Our Floating Steel Dry Dock is equipped with powerful Pumping Machinery and Appurtenances and has capacity for docking boats 600 feet long. The advantages of our dock permit of repairs being made **Expeditiously** and **Economically.**

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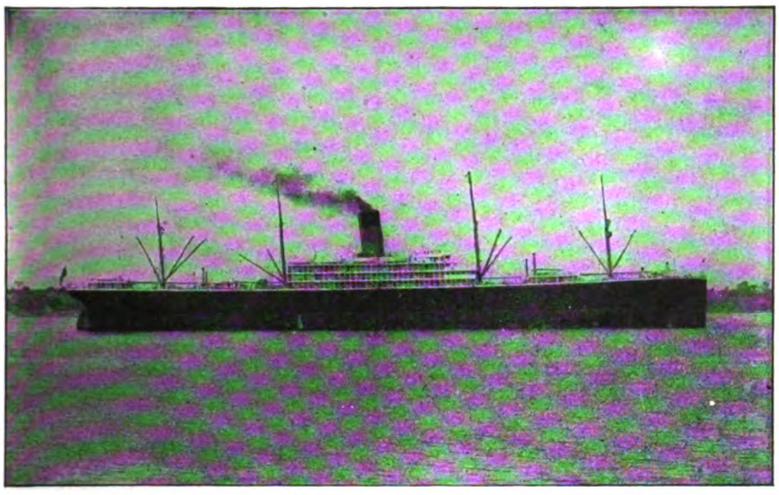

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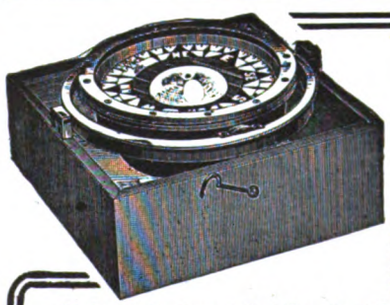

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WANTED and FOR SALE Department.

PROPOSALS.

U. S. Engineer Office, Milwaukee, Wis., June 28, 1906. Sealed proposals for removing old piers and building pile piers, Manitowoc Harbor, Wis., will be received here until 3 P. M. standard time, July 30, 1906, and then publicly opened. Information furnished on application. W. V. Judson, Major, Engrs.

U. S. Engineer Office, Jones Building, Detroit, Mich., June 4, 1906. Sealed proposals for widening St. Marys' Falls Canal will be received at this office until 2 p. m., July 24, 1906, and then publicly opened. Information furnished on application. Chas. E. L. B. Davis, Col. Engrs.

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Two 12-foot Scotch Boilers.
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One 200-h. p. Tregurtha Boiler.
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One Williamson steering Engine.
One 10 k. w. electric lighting Set.
One 15 k. w. electric lighting Set.
One Providence Windlass, 50 fathoms 1½ in. chain.
Two thrust Shafts and Bearings, 8½ in. diameter.
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Machinery for one other dredge. 14 x 16 tug. Lying at River Rouge, Mich.
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We Represent Only the Assured.

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on page 49 this issue.

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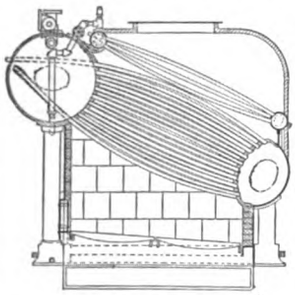
THE MOSHER PATENT WATERTUBE BOILER



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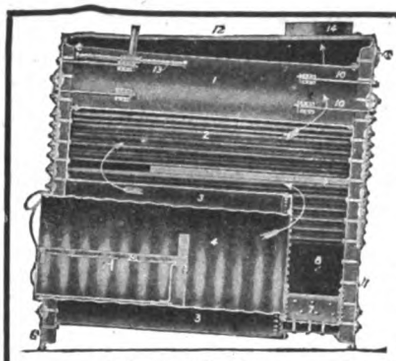

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Patent applied for. Investigate before buying any other.

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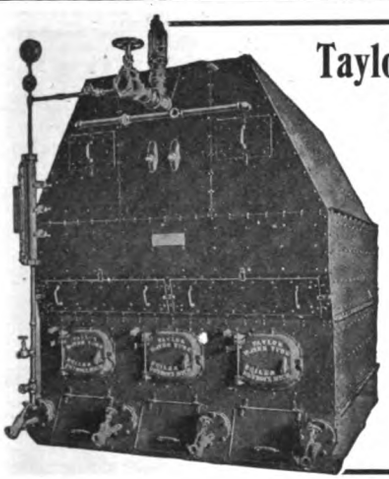

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Free circulation type.

Send for full description.

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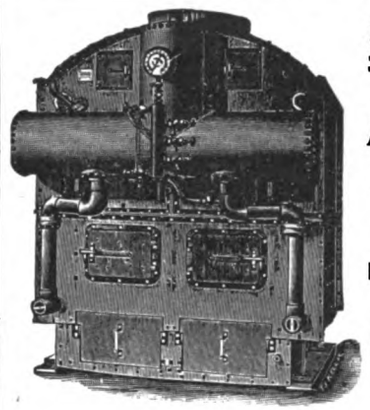

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Bear Evidence of Their

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We offer an

Engine for Direct-Connected Electric Plants

which we can guarantee

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That its construction is strong is self-evident

The shaft, rods, valve stems and other working parts are made of forged steel.

Every bearing is automatically lubricated.

In finish it is all that can be desired.

Write for full particulars and tests.

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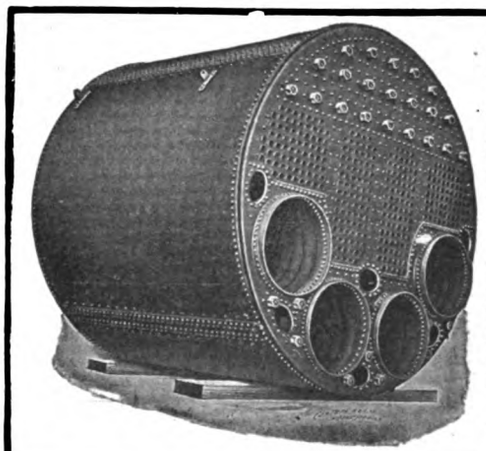

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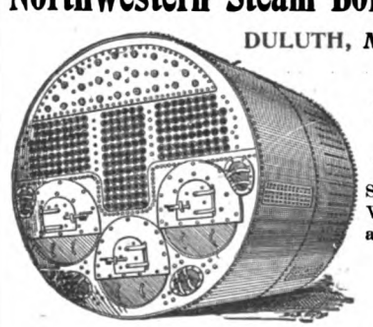

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Great Lakes Engineering Works....Detroit.

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ASH EJECTORS.
Great Lakes Engineering Works....Detroit.

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Almy Water Tube Boiler Co.....Providence, R. I.

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CHAIN HOISTS.
Boston & Lockport Block Co.....Boston, Mass.
Republic Belting & Supply Co.....Cleveland, O.

CHARTS.
Penton Publishing Co....Cleveland

CLOCKS (Marine and Ship's Bell) AND CHRONOMETERS.
Ritchie, E. S. & Sons.....Brookline, Mass.

COAL PRODUCERS AND SHIPPERS.
Hanna, M. A. & Co.....Cleveland.
Pickands, Mather & Co....Cleveland.
Pittsburg Coal Co.....Cleveland

COAL AND ORE HANDLING MACHINERY.
Brown-Hoisting Machinery Co.....Cleveland.

COMPASSES.
Ritchie, E. S. & Son.....Brookline, Mass.

CONDENSERS.
Great Lakes Engineering Works....Detroit.
Thropp & Sons Co., John E.....Trenton, N. J.
Wheeler Condenser & Engineering Co..... New York.

CONTRACTORS FOR PUBLIC WORKS.
Breymann Bros., G. H.....Toledo.
Buffalo Dredging Co.....Buffalo.
Dunbar & Sullivan Dredging Co.....Buffalo.
Graves & Stephens .....Cleveland.
Great Lakes Dredge & Dock Co.....Chicago.
Hickler Bros.....Sault Ste. Marie, Mich.
Hubbell Co., H. W..Saginaw, Mich.
Smith Co., L. P. & J. A...Cleveland.
Starke Dredge & Dock Co., C. H.....Milwaukee.
Standard Contracting Co..Cleveland.
Sullivan, M..... Detroit.

CORDAGE.
Baker & Co., H. H.....Buffalo.
Upson-Walton Co.....Cleveland.

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G. H. Breymann & Bro's

CONTRACTORS FOR PUBLIC WORKS

Dredging, Dock Building, Etc.

5, 6 AND 7 MARINE BUILDING
TOLEDO, OHIO.

GRAVES & STEPHENS

PUBLIC WORK CONTRACTORS

Dredges
Derrick Scows
Pile Drivers
Lighters
Concrete Plants

Commercial Bank Bldg. CLEVELAND, O.

Buffalo Dredging Co.

GENERAL CONTRACTORS
ON
SUBMARINE WORK

Office
D. S. Morgan Bldg. BUFFALO, N. Y.

GREAT LAKES DREDGE & DOCK CO.

OWNS AND OPERATES THE PLANTS OF THE FORMER COMPANIES:

Lydon & Drews Co.
Hausler & Lutz Co.
Green's Dredging Co.
Chicago Star Con. & D. Co.
McMahon & Montgomery Co.
Chicago Dredging & Dock Co.
Griffith, McDermott & Watt Dredging Co.
Duluth Dredge & Dock Co.
Lake Superior Contracting & Dredging Co.

Contractors for
RIVER AND HARBOR IMPROVEMENTS.
Main Office: 1319-1322 Chamber of Commerce - CHICAGO

DUNBAR & SULLIVAN DREDGING CO.
BUFFALO, N. Y.

Ready for Spring A New Tool

A REVOLVING CLAMSHELL DREDGE

which will do the following impossibilities to the ordinary dredge:

Excavate 60′ back from face of dock into scow or vice versa. Excavate at either end of itself and dump in scow at other end. This makes through cutting and cleaning narrow slips cheaply possible. Excavate trenches to 150′ or more depth. Excavate material and throw it one side 150′ from original site where there is four feet of water between dump and channel. Excavate shallow channels down to 4′ x 44′. Clean out boulders or obstructions without disturbing surrounding bottom Excavate close to docks without injury to dock. Anything that ordinary derrick will do up to 10 tons at 75′ radius.

This is an excellent wrecking tool.

Hickler Brothers

SAULT STE. MARIE, MICH.

MARINE RAILWAY

Capacity, 1,000 tons. Draft, 7½ ft. forward, 13½ ft. aft. Length on keel blocks, 180 ft.; over all, 190 ft.

Machine Shop, Foundry and Steam Forge, Dredges, Drill Boats and Derrick Scows.

Steamboat Fuel at Ashtabula.

Large Supplies of Best Quality.

Lighter Carrying Different Grades at all Times.

Fuel Scow with elevators and discharging spouts. Storage of 800 tons. Discharges 250 tons an hour into steamers while unloading cargo.

M. A. Hanna & Co., Miners and Shippers,
Main Office, Perry-Payne Bldg., Cleveland.

H. W. HUBBELL CO.

Submarine Work
of all kinds

Dredging Hard Material a Specialty.

SAGINAW - - MICH.

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Buyers' Directory of the Marine Trade.—*Continued.*

CORK JACKETS AND RINGS.
Armstrong Cork Co..Pittsburg, Pa.
Kahnweiler's Sons, D....New York.

CRANES, TRAVELING.
Brown-Hoisting Machinery Co.....
....,... Cleveland.

DIVING APPARATUS.
Morse, A. J. & Son.....Boston.
Schrader's Son, Inc., A..New York.

DREDGING CONTRACTORS.
Breymann & Bros., G. H....Toledo.
Buffalo Dredging Co.....Buffalo.
Dunbar & Sullivan Dredging Co....
.... Buffalo.
Great Lakes Dredge & Dock Co..
.... Chicago.
Hickler Bros. .....
.....Sault Ste. Marie, Mich.
Hubbell Co., H. W..Saginaw, Mich.
Smith Co., L. P. & J. A...Cleveland.
Starke Dredge & Dock Co., C. H...
....Milwaukee.
Sullivan, M..... Detroit.

DREDGING MACHINERY.
Quintard Iron Works Co.New York.

DRY DOCKS.
American Ship Building Co.....
.... Cleveland.
Atlantic Works ..East Boston, Mass.
Buffalo Dry Dock Co.....Buffalo.
Chicago Ship Building Co.....
.... Chicago
Cramp, Wm. & Sons..Philadelphia.
Detroit Ship Building Co.....
.... Detroit
Great Lakes Engineering Works....
.... Detroit.
Lockwood Mfg. Co.....
.....East Boston, Mass.
Milwaukee Dry Dock Co.....
....Milwaukee.
Newport News Ship Building Co...
.....Newport News, Va.
Shipowners' Dry Dock Co.Chicago.
Superior Ship Building Co.....
.... Superior, Wis.
Tietjen & Lang Dry Dock Co.....
..... Hoboken, N. J.
Toledo Ship Building Co.....Toledo.

DREDGE BUILDERS.
Manitowoc Dry Dock Co.....
..... Manitowoc, Wis.

DYNAMOS.
General Electric Co.....
....Schenectady, N. Y.
Thropp & Sons, John E.....
....Trenton, N. J.

ELECTRIC HOISTS AND CRANES.
General Electric Co.....
.....Schenectady, N. Y.

ELECTRIC LIGHT AND POWER PLANTS.
General Electric Co.....
.....Schenectady, N. Y.
Thropp & Sons, John E.....
.....Trenton, N. J.

ENGINE BUILDERS, MARINE.
American Ship Building Co.....
..... Cleveland.
Atlantic Works, East Boston, Mass.
Chicago Ship Building Co., Chicago.
Chase Machine Co.....Cleveland.
Cramp, Wm. & Sons, Philadelphia.
Detroit Ship Building Co., Detroit.
Fletcher, W. & A. Co., Hoboken, N. J.
Fore River Shipbuilding Co.....
..... Quincy, Mass.

ENGINE BUILDERS—Continued.
Great Lakes Engineering Works....
..... Detroit, Mich.
Hall Bros. ..... Philadelphia.
Lockwood Mfg. Co.....
.....East Boston, Mass.
Maryland Steel Co.....
.....Sparrows Point, Md.
Milwaukee Dry Dock Co., Milwaukee.
Mosher, Chas. D.....New York.
Newport News Ship Building Co....
.....Newport News, Va.
New York Ship Building Co.....
.....Camden, N. J.
Northwestern Steam Boiler & Mfg. Co. ..... Duluth, Mich.
Quintard Iron Works Co., New York.
Roach's Ship Yard.....Chester, Pa.
Sheriffs Mfg. Co.....Milwaukee.
Superior Ship Building Co.....
..... Superior, Wis.
Thropp, J. E. & Sons Co.....
.....Trenton, N. J.
Toledo Ship Building Co.....Toledo.
Trout, H. G.....Buffalo.

ENGINE ROOM TELEGRAPH CALL BELLS, ETC.
Cory, Chas. & Son.....New York.
Marine Mfg. Supply Co., New York.

ENGINEERING SPECIALTIES AND SUPPLIES.
Lunkenheimer Co. ..... Cincinnati.
Northwestern Steam Boiler & Mfg. Co. ..... Duluth, Minn.

ENGINEERS, MARINE, MECHANICAL, CONSULTING.
Hynd, Alexander ..... Cleveland.
Hunt, Robt. W. & Co.....Chicago.
Kidd, Joseph.....Duluth, Minn.
Mosher, Chas. D.....New York.
Nacey, James ..... Cleveland.
Roelker, H. B.....New York.
Wood, W. J.....Chicago.

FEED WATER PURIFIERS AND HEATERS.
Ross Valve Co.....Troy, N. Y.
Wheeler Condenser & Engineering Co. ..... New York.

FIXTURES FOR LAMPS, OIL OR ELECTRIC.
General Electric Co.....
.....Schenectady, N. Y.

FORGINGS FOR CRANK, PROPELLER OR THRUST SHAFTS, ETC.
Cleveland City Forge & Iron Co....
..... Cleveland.
Fore River Shipbuilding Co.....
..... Quincy, Mass.

FLUE WELDING.
Fix's S. Sons.....Cleveland.

FUELING COMPANIES AND COAL DEALERS.
Hanna, M. A. & Co.....Cleveland.
Parker Bros. Co., Ltd.....Detroit.
Pickands, Mather & Co., Cleveland.
Pittsburg Coal Co.....Cleveland.
Smith, Stanley B., & Co., Detroit.

FURNACES FOR BOILERS.
Continental Iron Works, New York.

GAS BUOYS.
Safety Car Heating & Lighting Co..
..... New York.

GAS AND GASOLINE ENGINES.
Chase Machine Co.....Cleveland.

GAUGES, STEAM AND VACUUM.
Lunkenheimer Co. ..... Cincinnati.

GAUGES, WATER.
Lunkenheimer Co.....Cincinnati, O.

GENERATING SETS.
General Electric Co.....
.....Schenectady, N. Y.

GRAPHITE.
Dixon Crucible Co., Joseph.....
.....Jersey City, N. J.

HAMMERS, STEAM.
Chase Machine Co.....Cleveland.

HOISTS FOR CARGO, ETC.
American Ship Building Co.....
..... Cleveland.
Brown Hoisting Machinery Co.....
..... Cleveland.
Chase Machine Co.....Cleveland.
Dake Engine Co.....
.....Grand Haven, Mich.
General Electric Co.....New York.
Hyde Windlass Co.....Bath, Me.
Marine Iron Co.....Bay City.

HOLLOW STAYBOLT IRON.
Falls Hollow Staybolt Co.....
.....Cuyahoga Falls, O.

HYDRAULIC DREDGES.
Great Lakes Engineering Works....
.... Detroit.

HYDRAULIC TOOLS.
Watson-Stillman Co., The.....
..... New York

ICE MACHINERY.
Great Lakes Engineering Works....
..... Detroit.
Roelker, H. B.....New York

INJECTORS.
American Injector Co.....Detroit.
Jenkins Bros.....New York.
Lunkenheimer Co. ..... Cincinnati.
Penberthy Injector Co.....
..... Detroit, Mich.

INSURANCE, MARINE.
Elphicke, C. W. & Co.....Chicago.
Gilchrist & Co., C. P.....Cleveland.
Hawgood & Co., W. A., Cleveland.
Helm & Co., D. T.....Duluth.
Hutchinson & Co.....Cleveland.
McCarthy, T. R.....Montreal.
McCurdy, Geo. L.....Chicago.
Mitchell & Co.....Cleveland.
Parker Bros. Co., Ltd.....Detroit.
Peck, Chas. E. & W. F.....
.....New York and Chicago.
Prindiville & Co.....Chicago.
Richardson, W. C.....Cleveland.
Sullivan, D. & Co.....Chicago.

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Standard Contracting Co.

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For Railroads, Dredging, Dock Building, Concrete, Submarine work, &c.

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AND
SUBMARINE PIPE LAYING.

Canal Street, West of First Avenue,

Milwaukee, - - Wisconsin.

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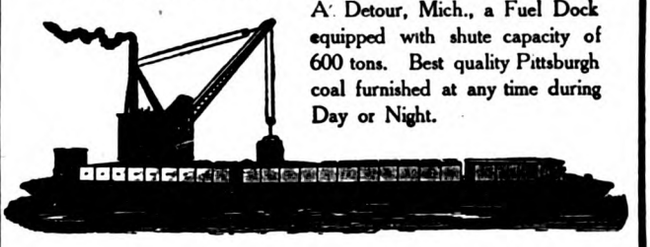
FUEL LIGHTERS at Buffalo, Erie, Ashtabula and Cleveland. At Detour, Mich., a Fuel Dock equipped with shute capacity of 600 tons. Best quality Pittsburgh coal furnished at any time during Day or Night.



Western Reserve Building, CLEVELAND, O.

M. SULLIVAN,

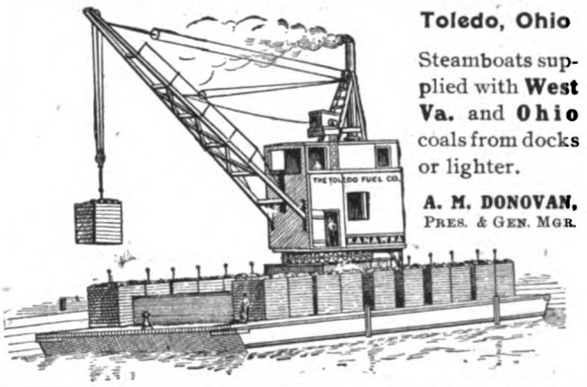
DREDGING OF ALL KINDS.

THE REMOVING OF DEEP WATER EARTH AND ROCK A SPECIALTY. - - -

53 Woodward Ave. Terrace,
DETROIT, - - - MICH.

The Toledo Fuel Co.

Toledo, Ohio



Steamboats supplied with **West Va.** and **Ohio** coals from docks or lighter.

A. M. DONOVAN,
PRES. & GEN. MGR.

New Fast Train to Columbus

THE COLUMBUS FLYER

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BIG FOUR ROUTE

Leaves UnionStation 6:15 p. m., daily except Sunday, with combination Baggage and Smoking Car, highback coaches and Pullman Buffet Parlor Cars (serving light supper en-route), Stopping at Wellington, New London, Shelby, Crestline, Galion and Delaware and arrives at Columbus 9:35 p. m. Get tickets and Pullman seats at Big 4 Ticket office, No. 532 Euclid Avenue or Union Depot.

THIS IS A VERY FAST TRAIN **Try It**

The Water Light

Self-Igniting Inextinguishable For

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Repairs and Construction.
Salvage
Submarine
General Illumination.

Send for Sample.

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IRON ORE AND PIG IRON.
Bourne-Fuller Co.....Cleveland, O.
Hanna, M. A. & Co.....Cleveland.
Pickands, Mather & Co., Cleveland.

LAUNCHES—STEAM, NAPHTHA, ELECTRIC.
Truscott Boat Mfg. Co.....
.....St. Joseph, Mich.

LIFE PRESERVERS, LIFE BOATS, BUOYS.
Armstrong Cork Co.....Pittsburg.
Carley Life Float Co.....
.....New York, N. Y.
Drein, Thos. & Son.....
..... Wilmington, Del.
Kahnweiler's Sons, D.....New York.

LIGHTS, SIDE AND SIGNAL.
Russell & Watson.....Buffalo.

LOGS.
Nicholson Ship Log Co., Cleveland.
Walker & Sons, Thomas.....
..... Birmingham, Eng.

LUBRICATING GRAPHITE.
Dixon Crucible Co., Joseph.....
.....Jersey City, N. J.

LUBRICATORS.
Lunkenheimer Co. ..... Cincinnati.

LUMBER.
Martin-Barriss Co. ..... Cleveland.

MACHINISTS.
Chase Machine Co.....Cleveland.
Hickler Bros., Sault Ste. Marie, Mich.
Lockwood Mfg. Co.....
.....East Boston, Mass.

MACHINE TOOLS (WOOD WORKING).
Atlantic Works, Inc....Philadelphia.

MARINE RAILWAYS.
Hickler Bros., Sault Ste. Marie, Mich.

MARINE RAILWAYS, BUILDERS OF.
Crandall & Son, H. I.....
.....East Boston, Mass.

MATTRESSES, CUSHIONS, BEDDING.
Fogg, M. W.....New York

MECHANICAL DRAFT FOR BOILERS.
American Ship Building Co.....
..... Cleveland.
Detroit Ship Building Co., Detroit.
Great Lakes Engineering Works....
..... Detroit.

METALLIC PACKING.
Katzenstein, L. & Co., New York.
The National Metallic Packing Co..

MOTORS, GENERATORS—ELECTRIC.
General Electric Co.....
.....Schenectady, N. Y.

NAUTICAL INSTRUMENTS.
Ritchie, E. S., & Sons.....
..... Brookline, Mass.

NAVAL ARCHITECTS.
Hynd, Alexander .....,Cleveland
Kidd, Joseph .....Duluth, Minn.
Mosher, Chas. D.....New York.
Nacey, James .....Cleveland
Wood, W. J.....Chicago

OAKUM.
Stratford, Oakum Co.....
.....Jersey City, N. J.

OILS AND LUBRICANTS.
Dixon Crucible Co., Joseph.....
.....Jersey City, N. J.

PACKING.
Jenkins Bros.....New York.
Katzenstein, L. & Co...New York.
Robertson, Jos. L. & Sons.....
....New York.
The National Metallic Packing Co...
..... Oberlin, O.
Republic Belting & Supply Co.....
.....Cleveland, O.

PAINTS.
Baker, Howard H. & Co....Buffalo.
Upson-Walton Co.....Cleveland.

PATTERN SHOP MACHINERY.
Atlantic Works, Inc. ..Philadelphia.

PILE DRIVING AND SUBMARINE WORK.
Buffalo Dredging Co.....Buffalo.
Dunbar & Sullivan Dredging Co....
.... Buffalo.
Great Lakes Dredge & Dock Co....
.... Chicago.
Hickler Bros..Sault Ste. Marie, Mich.
Hubbell Co., H. W...Saginaw, Mich.
Parker Bros. Co., Ltd.....Detroit.
Smith Co., L. P. & J. A...Cleveland.
Starke Dredge & Dock Co., C. H...
....Milwaukee.
Sullivan, M.....Detroit.

PIPE, WROUGHT IRON.
Bourne-Fuller Co.....Cleveland, O.

PLANING MILL MACHINERY.
Atlantic Works, Inc....Philadelphia.

PLATES—SHIP, STRUCTURAL, ETC.
Bourne-Fuller Co.....Cleveland, O.
Otis Steel Co.....Cleveland.

PRESSURE REGULATORS.
Ross Valve Co.....Troy, N. Y.

PROPELLER WHEELS.
American Ship Building Co.....
..... Cleveland.
Atlantic Works ..East Boston, Mass.
Cramp, Wm. & Sons..Philadelphia.
Detroit Ship Building Co....Detroit.
Fore River Shipbuilding Co.....
..... Quincy, Mass.
Great Lakes Engineering Works....
.... Detroit.
Hyde Windlass Co.....Bath, Me.
Lockwood Mfg. Co.....
.....East Boston, Mass.
Milwaukee Dry Dock Co.....
....Milwaukee.
Newport News Ship Building Co..
.....Newport News, Va.
Roelker, H. B.....New York.
Sheriffs Mfg. Co.....Milwaukee.
Superior Ship Building Co.....
.....Superior, Wis.
Thropp & Sons Co., J. E.....
.....Trenton, N. J.
Toledo Ship Building Co.....Toledo.
Trout, H. G.....Buffalo.

PROJECTORS, ELECTRIC.
General Electric Co.....
.....Schenectady, N. Y.

PUMPS FOR VARIOUS PURPOSES.
Great Lakes Engineering Works..
.... Detroit.
Kingsford Foundry & Machine Works .....Oswego, N. Y.
Wheeler Condenser & Engineering Co. .....New York.

RANGES.
Stamford Foundry Co.....
.....Stamford, Conn.

REFRIGERATING APPARATUS.
Great Lakes Engineering Works....
.... Detroit.
Roelker, H. B.....New York.

REGISTER FOR CLASSIFICATION OF VESSELS.
Great Lakes Register.....Cleveland.

RIVETS, STEEL FOR SHIPS AND BOILERS.
Bourne-Fuller Co.....Cleveland, O.

RUBBER SUPPLIES.
Republic Belting & Supply Co.....
..... Cleveland, O.

SAFETY VALVES.
Lunkenheimer Co.....Cincinnati.

SAIL MAKERS.
Baker, Howard H. & Co....Buffalo.
Upson-Walton Co.....Cleveland.

SALVAGE COMPANIES.
See Wrecking Companies.

SEARCH LIGHTS.
General Electric Co.....
.....Schenectady, N. Y.

SHEARS.
See Punches, and Shears.

SHIP AND BOILER PLATES AND SHAPES.
Bourne-Fuller Co.....Cleveland, O.
Otis Steel Co.....Cleveland.

SHIP BUILDERS.
American Ship Building Co.....
.... Cleveland.
Atlantic Works ..East Boston, Mass.
Buffalo Dry Dock Co.....Buffalo.
Cramp, Wm. & Sons..Philadelphia.
Chicago Ship Building Co..Chicago.
Detroit Ship Building Co....Detroit.
Fore River Ship Building Co.....
....Quincy, Mass.
Great Lakes Engineering Works....
....Detroit.
Lockwood Mfg. Co.....
.....East Boston, Mass.
Manitowoc Dry Dock Co.....
.....Manitowoc, Wis.
Maryland Steel Co.....
.....Sparrow's Point, Md.
Milwaukee Dry Dock Co.....
..... Milwaukee.
Newport News Ship Building Co...
.....Newport News, Va.
New York Shipbuilding Co.....
.....Camden, N. J.
Roach's Ship Yard.....Chester, Pa.
Shipowner's Dry Dock Co..Chicago.
Toledo Ship Building Co.....Toledo.

SHIP CHANDLERS.
Baker, Howard H. & Co....Buffalo.
Marine Mfg. & Supply Co.....
..... New York.
Upson-Walton Co.....Cleveland.

SHIP DESIGNERS.
Kidd, Joseph .....Duluth.
Steel, Nacey, & Hynd....Cleveland.
Wood, W. J.....Chicago.

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FOR TUG BOAT USE

Easy to adjust, and can be handled by any one.

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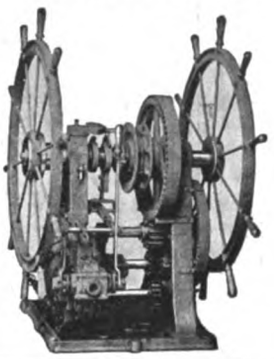
Sheriffs Mfg. Co.

MILWAUKEE, WIS.

Established 1854

Dake Pilot House



Steam Steerer

For Tugs and Steamers. Simple, Durable, Efficient and practically noiseless. Can easily be changed to hand gear if necessary.

DAKE ENGINE CO.,

Grand Haven, Mich.

Dixon's Graphite for Marine Lubrication

Lieut Dinger, U. S. N., said: "Flake Graphite is not affected, chemically or physically, by any temperature encountered in a cylinder—pumps run better with graphite and a little kerosene than with oil."

His complete article is given in Booklet 77-C. Free on request together with test samples of Dixon's Graphite.

JOSEPH DIXON CRUCIBLE CO.

JERSEY CITY, N. J.

BELTING

The Republic Belting and Supply Company

Cleveland, O.

FORMERLY THE BODIFIELD BELTING CO.

Manufacturers of

LEATHER BELTING

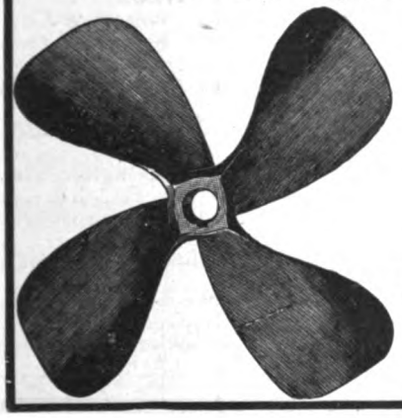
"REPUBLIC"

Mechanical Rubber Goods.

Goodyear's Interlocking Rubber Tiling.

LEATHER-RUBBER —CANVAS-COTTON—

Thirtv Years' Experience building



Engines and Propeller Wheels.

H. G. TROUT,

King Iron Works,

226 Ohio St.,

BUFFALO, N. Y.

Aids to Navigation

are of vital importance to vessel interests.

SCHERZER ROLLING LIFT BRIDGES

aid navigation and meet with the approval of all vessel interests, because of the wide and unobstructed channel provided for navigation, enabling vessels to pass easily and rapidly through the draw.

The Scherzer Rolling Lift Bridge Co.

Main Offices: 1616 Monadnock Block, CHICAGO, U. S. A.

ANY SIZE, OUTSIDE OR INSIDE DIAMETER. AVERAGE LENGTH OF HOLLOW BARS EIGHT TO TEN FEET.

FALLS HOLLOW STAYBOLT Co

STAYBOLT BARS

BOTH HOLLOW AND SOLID. MADE OF BEST QUALITY DOUBLE REFINED CHARCOAL IRON OR STEEL. CUYAHOGA FALLS. O. U.S.A.

Makers of only the Highest Quality of Staybolt Material, in Hollow and Solid Bars, from the Best Double-Refined Charcoal Iron or Steel.

FALLS HOLLOW STAYBOLT IRON Is the only Reliable Flexible Staybolt in the World.

The Only Staybolt Iron which responds in service to the expansion and contraction of fire box; which relieves the material in molecular strains; which is self protective from burning; which does not make the side sheets crack; which earns its own cost in oxygen through it to the fire; always sure in giving warning of breakage.

The Staybolt which lasts longest, requires least repairs, gives longest life to the fire box, and the longest service in the engine on the rails.

In use by Leading Railways of the United States, Canada, Mexico, Japan and Norway. Also by Marine Engineers and the United States Government. And by the Manufacturers of Mining Drills and by others requiring absolutely reliable material.

GEO. STRATFORD OAKUM CO.

JERSEY CITY, NEW JERSEY.

Established 1860

Manufacturers of all grades of

Oakum

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FOR SALE AT SHIP CHANDLERS EVERYWHERE.

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SHIP LANTERNS AND LAMPS.
Upson-Walton Co..... Cleveland.

SHIP TIMBER.
Martin-Barriss Co.....Cleveland.

SMOOTH-ON COMPOUND, FOR REPAIRS.
Smooth-On Mfg. Co.....
.....Jersey City, N. J.

STAYBOLT IRON OR STEEL BARS, HOLLOW OR SOLID.
Falls Hollow Staybolt Co.....
.....Cuyahoga Falls, O.

STEAM VESSELS FOR SALE.
Holmes, Samuel .....New York,
McCarthy, T. R.....Montreal, Can.

STEAMSHIP LINES, PASS, AND FREIGHT.
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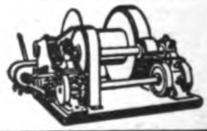

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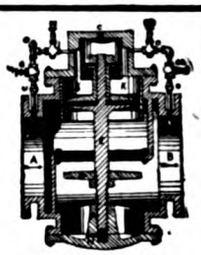

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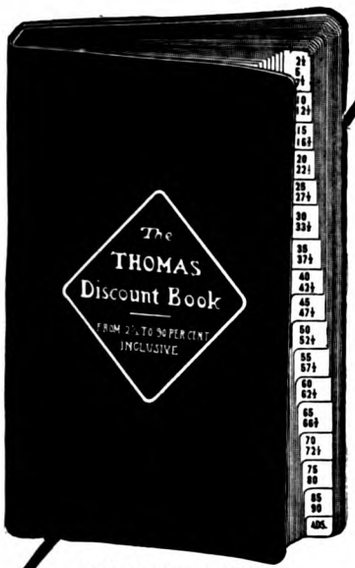

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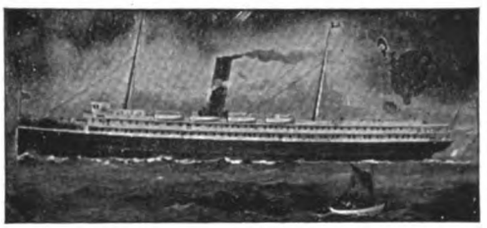

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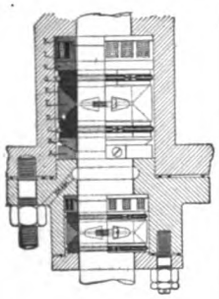

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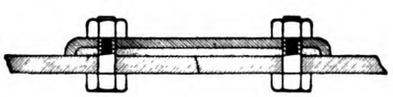

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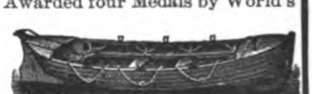

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